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AUDITORY, VISUAL AND INTELLECTUAL ABILITY PATTERNS IN GRADE ONE CHILDREN

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Ability Patterns of Grade One Children submitted by Elizabeth Anne Blowers in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Special Education.

ABSTRACT

This study was designed to investigate a number of auditory and visual abilities which supposedly are related to early school achievement by assessing their relationships with the criteria variables of reading readiness, early academic achievement and intellectual development and by examining their relationships with each other. Predictor variables included measures of auditory discrimination, meaningful and nonmeaningful auditory sequential memory, receptive vocabulary, auditory closure, sound blending, spatial relations, visual figure-ground differentiation, visual sequential memory, visual closure and all subtests of the Frostig Developmental Test of Visual Perception. Criteria variables were the Metropolitan Readiness Tests, the Stanford Achievement Test, Primary 1, and the Wechsler Intelligence Scale for Children.

Subjects were fifty girls and fifty-six boys ranging in age from sixty-seven months to seventy-eight months who were attending regular grade one classes in the public school system of a large Canadian urban centre. The subjects were selected by their teachers as apparently experiencing some difficulty in school learning.

Coefficients of correlation were found for the relationships between predictor and criteria variables. Stepwise multiple regression analysis was used to investigate the level of prediction of the criteria variables from the predictor variables. Coefficients of correlation were found for the relationships among the predictor

variables and an attempt was made to determine if patterns of abilities appeared to be indicated from the results of the study.

Two major areas tended to emerge from the results of the study. One area centered on the identification of useful predictors of the criteria variables used, while the second area centered on the relationships found among predictor variables and between predictor and criteria variables.

Prediction of readiness scores and Wechsler verbal scores was relatively strong at over 50%. Prediction of Wechsler performance scores and Stanford arithmetic achievement was moderate at over 30%, while prediction of reading achievement was weak at under 20%. Meaningful auditory memory, receptive vocabulary and various of the last three Frostig subtests tended to be the most useful predictors, with Ayres spatial relations, auditory discrimination and sound blending being useful predictors for a few specific criteria.

When relationships among the variables were examined further, two levels of abilities among the predictor variables were identified. The first level, called basal abilities, tended to show weaker relationships with criteria variables while showing relatively strong relationships with three of the predictor variables, called here the integrated abilities.

These integrated abilities of receptive vocabulary, meaningful auditory memory and spatial orientation as assessed by three Frostig subtests were the best general predictors of the criteria variables. It is postulated that the development of the integrated abilities is

based in part on the previous development of certain basal abilities. A hierarchical structure of abilities is suggested in which basal abilities influence the development of integrated abilities which, in turn, influence criteria variables such as academic achievement and intellectual development.

In remedial developmental programing, when deficient basal abilities are diagnosed, it is suggested that remedial work should be directed not only at overcoming basal disabilities, but also at developing related integrated abilities, to allow for improvement in the criteria variables of early academic learning.

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CHAPTER I

THE PROBLEM

Early child development can be studied in a variety of contexts. This study is concerned with exploring the academic and intellectual development of children in grade one, particularly as this development relates to certain underlying abilities which are usually described as perceptual or learning abilities.

The young child entering a formal school setting has a wide variety of past learning on which to draw. Various assessment techniques have been devised in the past decade which purport to measure past learnings which are classified as learning abilities and perceptual skills.

Certain classificatory instruments are in common use during the primary school years. These include reading readiness and achievement tests and, where the child's general intellectual functioning is in question, intelligence tests. Academic achievement and intellectual functioning are represented generally by composite test scores, representing a mean score derived from a number of subtests, which in turn are based on a wide variety of underlying abilities. At best, achievement and intelligence test scores are global indicators of underlying abilities. The new ability tests may be able to assist in the investigation of intellectual and academic functioning by discriminating between some component abilities serving as bases for this functioning.

On a more practical level, it generally is assumed to be possible to provide developmental programs which will be of benefit to the child with certain skill deficits. Programming to increase learning abilities is a common practice in some special education, remedial and readiness classes. The amount of test information on children with learning difficulties that may be made available to teachers has increased enormously in the last decade. The problem faced by teachers is to select those test behaviours which are most related to school success and to build developmental programs aimed at increasing deficient abilities.

Pressure on school boards to provide suitable programs for preschool and primary children with weak areas of development has increased enormously with the widespread use of simple screening devices such as the Denver Developmental Screening Test (Frankenburg & Dodds, 1967) which make it possible to survey entire health units for four and five year old children showing atypical development. The assumption that early diagnosis and developmental programming can lead to a worthwhile reduction in the learning difficulties of children appears to be general among professional educators, parents and medical personnel. This situation places a heavy responsibility upon school personnel, as research information both on identifying learning patterns in children and on interventional techniques to improve these patterns is inadequate for purposes of classroom programming.

Statement of the Problem

A number of relatively new assessment techniques have been devised which purport to measure visual and auditory abilities which are assumed to be bases for children's learning. This study examined some of these learning ability tests to explore their relationships with each other, with reading readiness and academic ability and with intellectual achievement of grade one children. The purposes were to attempt to differentiate the abilities required for success in the intellectual and academic areas and to obtain further information on relationships among the processes assessed by certain ability tests.

This study was exploratory in nature. The relationships between some commonly used school tests and the new learning ability tests described were examined to add to the understanding of the abilities important to children in grade one.

Justification for the Study

There are many studies examining the relationships between specific perceptual abilities and reading. In general, previous studies have been done with subjects in grade three or higher grades. A number of auditory and visual learning abilities as they are related to reading readiness, reading, arithmetic and intellectual development in grade one children were examined in this study. Therefore, the present study investigated younger children and a wider range of abilities than is customary, as well as adding the dimension of intellectual development.

The tests used in this study include some that are in common use by schools. This allows for the possibility of obtaining additional information on familiar instruments.

Generally, previous studies have used simple correlations to examine the relationships between single learning abilities and criteria variables such as reading. In this study, stepwise multiple regression analysis was used to allow the examination of the relationship between several predictor variables and the criterion variables. It was hoped that better prediction and the avoidance of the deceptive appearance of relatively simple relationships between predictors and criteria would be provided by this type of analysis.

CHAPTER II

REVIEW OF RELATED RESEARCH

The Role of Perceptual Learning Abilities in Early School Experiences

In assessing the preschool child, the examiner usually must make assumptions about underlying perceptual skills with only the evidence available from the child's motor behaviours, for example, speech and drawing. The school age child generally can respond to a wider variety of assessment techniques, making more specific diagnosis possible. A considerable amount of research on the perception of the young school child has been done, much by reading specialists who tend to limit investigation to their own field. The effect of inadequate perceptual skills on arithmetic, spelling, writing, motor ability and social and emotional development recently has received some attention by investigators interested in learning disabilities. Some of this latter research has been marred by having a definite bias toward certain of the many commercial programs presently available for classroom use with learning disabled children (Weintraub, 1973).

Other problems increase the difficulty of evaluating the research on perception. Confused terminology makes comparison of studies difficult unless the reader is familiar with the tests used. For example, a test of auditory memory may involve assessing the child's ability to remember tones, nonsense words, numbers, sentences or story detail. Closely related to the problem of terminology is the

difficulty in relating various aspects of the same skills. The various auditory memory abilities mentioned appear to have some common memory factor, but this may not appear when the tests are analyzed. In general, instruments commonly used to assess perception have not been shown to be particularly valid (Weintraub, 1973).

Learning Abilities in the Primary Grades

(a) Auditory Discrimination

Auditory discrimination is the capacity to distinguish phonemes in speech (Wepman, 1959). A hearing loss reduces auditory discrimination, but poor discrimination can exist without a depressed threshold of hearing. Sanders (1971) considered the development of auditory discrimination to depend upon the type of sounds encountered, their frequency and their significance to the child.

A serious deficiency in auditory discrimination could effect all areas of language development. Blank (1968) considered the reading failures of some children secondary to an oral language deficit caused by an inability to hear and discriminate sounds accurately. Hildreth (1946) concluded that inaccurate discrimination and poor articulation may be common factors in both reading and speech difficulties. It has been noted that as the number of articulation errors increases, the reading readiness level of children tends to become less adequate (Weaver, Furbee & Everhart, 1960).

Several studies have examined the effect of the inadequate development of auditory discrimination on beginning reading. Durrell and Murphy (1953) observed that among their clinical cases almost every

child seen with reading achievement below the grade one level had a marked inability to discriminate sounds in words and concluded that this is the skill most frequently deficient in beginning reading. Children with poor auditory skills who are taught reading by a phonetic approach are clearly at a disadvantage (Bond, 1935). Thompson (1963) found auditory discrimination scores useful as predictors of early reading success.

Auditory discrimination may affect the development of auditory memory, while auditory discrimination and vocabulary may affect each other simultaneously. The child who has difficulty in differentiating sounds probably will not learn the meanings of similar sounding words at a normal rate. At the same time, it appears to be easier to discriminate sounds when the words used are familiar (Elenbogen & Thompson, 1972; Katz, 1967). It would appear that when discrimination is to be assessed, the child's level of vocabulary should be taken into account.

In the formal assessment of auditory discrimination, three general approaches are used. Some experimental work was done on the discrimination of tones of different pitch, loudness and duration (Buktenica, 1971) with adaptations of the Seashore Test of Musical Talent (Seashore, Lewis & Saetviet, 1928). A second approach is the use of picture tests in which the examiner says a word and the child selects a corresponding picture. In the third approach, the examiner says two words and the child indicates whether the words he heard were the same or were two different words.

The effect of vocabulary level on tests of auditory discrimination has been discussed. Another factor that may affect discrimination scores is auditory memory (Goetzinger, Dirks & Baer, 1960).

In summary, it appears that there may be a considerable amount of relationship among abilities in discriminating sounds in words, articulation, early reading, particularly when a phonetic approach is used, vocabulary and the recall of auditory stimuli.

(b) Auditory Closure and Sound Blending

Auditory closure and sound blending appear to be rather specific skills which have not been investigated fully as yet. Closure refers to the ability to perceive incomplete stimuli as whole (Sanders, 1971) which Thurstone (1944) isolated as a factor of perception. Auditory closure appears to be important in understanding partially heard auditory messages and may be of great importance to the partially deaf or bilingual child. Closure may be based in part on vocabulary and discrimination.

Sound blending, the ability to hear isolated sounds and blend them into words, was found to be related both to closure and to spelling (Bannatyne & Wichiarajote, 1969). In the school child, skill at sound blending may be related closely to exposure to a phonetic approach in reading, as well as to closure, discrimination, auditory memory and vocabulary.

Closure and sound blending are assessed by various tests. One of the most familiar instruments in use is the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy & Kirk, 1968).

(c) Auditory Memory and Sequencing

Auditory memory and sequencing appear to play an important role in several areas including language development, vocabulary and articulation (Eisenson, 1965). A deficiency in meaningful auditory memory may lead to a tendency to confuse instructions and a failure to learn from auditory presentations. Zigmond (1969) found dyslexic children to be deficient in both meaningful memory for sentences and nonmeaningful memory for digits, rhythms, words and nonsense words. De Hirsch, Jansky and Langford (1966) found the nonreaders in their sample to be inferior to more successful children in their grasp of story details and in sequencing.

Sequencing, the ability to recall events in the order in which they occurred, may be a skill which transcends the usual division assumed to differentiate auditory and visual perception. De Hirsch (1967) referred to sequencing as the child's ability to pattern events in time and space. When temporal patterning ability is inadequate, various deviant behaviours may occur, including confused word order, an inability to learn arithmetic and extreme difficulty in copying shapes.

Many tests of auditory memory and sequencing are in common use, ranging from tapping to repeating sentences and retelling stories.

(d) Vocabulary

Vocabulary development was discussed briefly both as it influences and as it is influenced by discrimination, closure and memory. Knowledge of word meaning is a basic skill in language development and appears to depend on the integrity of a number of underlying abilities.

Vocabulary commonly is assessed by having the child indicate a picture which corresponds to the word spoken by the examiner or by the child orally defining words.

(e) Visual Figure-Ground Discrimination

An inability to fixate visually on certain stimuli while relegating other stimuli to the background seems to present some children with serious learning problems. Failing readers in the de Hirsch, Jansky and Langford study (1966) differed from slow starting readers on several factors, including severe figure-ground deficits. Silver and Hagin (1963; 1966) found that childhood dyslexics who achieved adequate reading ability as adults tended to be those who displayed few figure-ground errors as children. Figure-ground differentiation was found to be related to reversal tendencies (Krise, 1952) which are considered as a problem only if they persist after the age of seven or eight (Howard & Templeton, 1966).

In summary, figure-ground discrimination appears to be a basic skill in all visual perceptual tasks. When discrimination is developed inadequately, there may be confusion and hesitations in the interpretation of visual stimuli leading to a variety of reading, writing, motor and perceptual anomalies.

Frequently figure-ground discrimination is assessed by picture tests. The relevant visual stimulus may be obscured by lines or it may be superimposed on other figures. The child may be asked to show the examiner the required figure or he may trace over the figure.

(f) Visual Closure

Visual closure, the ability to recognize a shape or a word when only part of it is visible, may be related to figure-ground discrimination (Ayres, 1965). Elkind, Horn and Schneider (1965) found visual closure positively correlated with general reading ability. Tinker (1965) discussed the tendency of both children and adults to use only parts of words for identification, for example, beginning, ascending and descending letters. When reading is rapid, the reader tends to rely on closure and context cues for most word recognition. Goins (1958), in her factoral analysis of perceptual and reading tests, found one of the two factors isolated to be strength of closure which she considered to be related to the ability to keep in mind a figure against distraction. This description appears to relate Goins' closure to both visual memory and figure-ground discrimination.

Good visual closure tests do not appear to be readily available. One that is in common use is the visual closure subtest on the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy & Kirk, 1968) in which the child finds partially hidden pictures of common objects. This task may not be closely related to closure in reading and is easily contaminated by previous experience (Golden & Steiner, 1969).

(g) Visual Memory and Sequencing

Children who are poor at reading (Vernon, 1971) and spelling (Bannatyne & Wichiarajote, 1969) frequently have shown visual memory deficits. Lyle and Goyen (1968) investigated three aspects of visual memory, immediate recall, delayed recall and sequential recall. Retarded readers performed at a significantly poorer level than normal readers

on all three tests, but in a manner similar to that of younger normal readers. The authors concluded that visual memory is a developmental skill, that retarded readers appear to show a general perceptual deficit and that this deficit may be related to Goins' factor of speed of decoding (Goins, 1958).

Visual memory appears to be a complex skill, based in part on accurate visual discrimination of stimuli and a sequential, possibly spatial, element which as yet has not been clearly isolated and defined. Many techniques are used to assess visual memory including bead stringing, memory for designs and the recognition and/or replication of letters and words.

(h) Copying

Visual-motor skills frequently are assessed by analyzing children's ability to copy forms and symbols. Research findings on the effectiveness of copying skills as predictors of future school performance are not clear. Copying was one of the major weaknesses of the failing readers in the de Hirsch, Jansky and Langford study (1966). Kephart (1958) analyzed differences between high and low scores in the Metropolitan Readiness Tests (Hildreth & Griffiths, 1955) and found that copying scores showed the most variation. The implications of this finding were not discussed.

The relationship between copying and school achievement is obscured to some extent because various tests appear to give different results. Familiar tests include the Bender-Gestalt (Bender, 1938), the Goodenough Harris Draw-a-Person (Harris, 1963) which is a drawing

rather than a copying test and which is included in an adapted form in the Metropolitan Readiness Tests, the Visual Achievement Forms (Winter Haven Lions Club, 1955) which are incorporated in the Purdue Perceptual Motor Survey (Roach & Kephart, 1966) and the Graham-Kendall Memory for Designs (Graham & Kendall, 1960) which includes a strong visual memory component. The Draw-a-Person test appears to have the least in common with the other tests and appears to be measuring abilities besides those in the perceptual-motor area (Waters, 1961). Keogh (1968) found that at all ages, children in the poorest socio-economic areas showed the lowest scores on the Bender-Gestalt, but not necessarily the lowest scores on the Draw-a-Person.

There have been several attempts to use the results of copying and drawing tests as predictors of school achievement. Huelsman (1958) considered that the relationship between copying of the Visual Achievement Forms and reading disappears when intelligence is held constant, but other investigators (Robinson, Letton, Mozzi & Rosenbloom, 1958) found the relationship to be low but constant at the grade one level. A three year study (Robinson, Mozzi, Wittick & Rosenbloom, 1960) was done to determine the relationship of Visual Achievement Form scores with other measures at grades one, two and three. Visual Achievement Test scores of grade one children showed a slight relationship with grade one scores in reading and intelligence, but not with writing or visual efficiency. The grade one Visual Achievement Test scores remained significantly related to the reading achievement of the children when they were in grades two and three. The Visual Achievement Test scores obtained by the children in grade two also were related to reading achievement. However, the Visual Achievement Test scores obtained

when the children reached grade three showed no relationship with reading achievement. As predictors of reading failure, the scores were of limited value, identifying only eleven of the twenty-four children in the lower third of the reading class. This study appears to indicate the change that occurs in perceptual skills after age six and the difference in their significance for school learning at various age levels. It may be of considerable importance to assess and develop deficient visual-motor skills in the preschool and grade one child. The role of these skills in the learning of the eight or nine year old child may be minimal.

Performance on the Bender-Gestalt and reading readiness tests was found to be associated (Snyder & Freud, 1967). Keogh and Smith (1967) examined this relationship and found that while high Bender scores were generally associated with good school achievement, there was no clear relationship between poor Bender scores and achievement. These authors suggested that the Bender may serve as a useful screening device to indicate young children who may later develop difficulty with school learning.

In summary, while copying and drawing tests cannot be considered as sufficient by themselves to indicate children with potential learning problems, they may serve as useful and quick screening tools to decide which children need further assessment. The most useful copying test in terms of prediction might be one that includes both designs and letters, as does the copying subtest of the Metropolitan Readiness Tests (Hildreth & Griffiths, 1955). The use of copying tests with children over eight years of age seems less suitable than their use with younger children. Copying and drawing tasks

require the use of a complex set of skills including fine motor co-ordination, figure-ground discrimination and a knowledge of two-dimensional spatial relations.

Intellectual Assessment, Perceptual Development and Reading

As Vernon (1960) indicated, intelligence test items, even those described by Thurstone (1938) as containing a high degree of the verbal-educational factor, also contain a spatial-perceptual component. It is inevitable that both auditory and visual perceptual abilities will influence intelligence scores. At the younger age levels, the Stanford-Binet is loaded heavily with visual perceptual tasks (Frostig, Lefever & Whittlesey, 1963) but these become less common at later age levels. The Wechsler Scales give considerable weight to visual perceptual and visual-motor skills at all age levels.

MacFarlane Smith (1964) considered that educational selection procedures tend to differentiate in favour of children with superior verbal ability and against those with superior spatial ability. Generally this seems to be true in reading, as many studies have found that children who fail in reading tend to be more deficient in verbal than in spatial factors. Almost two-thirds of the reading impaired children studied by Huelsman (1970) had lower verbal than performance Wechsler scores and generally were low in the information, arithmetic and coding subtests. Thompson (1963) found poor readers to be significantly higher on performance than on verbal intelligence scores. Research findings summarized by Strang (1969) indicated that poor readers tend to be characterized by low verbal scores and to be

extremely low in the information, arithmetic and coding subtests of the Wechsler Scales, with the digit span subtest frequently being the lowest of all. Kinsbourne and Warrington (1963) found two groups of backward readers, the group described in the previous studies who were verbally inefficient, and a second group who had lower performance scores than verbal scores on the Wechsler Scales. This second group was extremely low on the block design and object assembly subtests, which the authors felt was due to deficiencies in sequential ordering and an inability to recall and manipulate sequences. These conclusions together with Strang's (1969) finding that digit span, a verbal sequential memory task, was often the lowest score among the verbally deficient children, appear to suggest that sequencing is an ability which may strongly influence both verbal and performance scores of the Wechsler Scales.

Olson (1966 a; 1966 b) examined the relationship between scores on the Frostig Developmental Test of Visual Perception (Frostig, Lefever & Whittlesey, 1961) and the California Test of Mental Maturity (Sullivan, Clark & Tiegs, 1957). Children assessed were in grade three, the level at which the authors of the Frostig test consider the effect of visual perception on other behaviours to be decreasing rapidly (Frostig & Maslow, 1969). Olson (1966 a) found that scores on the California Test and total Frostig scores were highly correlated, with the Frostig subtests of figure-ground discrimination and form constancy most significantly related to the California scores.

In summary, it appears that perceptual abilities are assessed to an unknown extent by intelligence tests. Because of this, it was

considered desirable to establish more clearly the relationship between specific perceptual test results and intelligence tests, particularly the Wechsler Intelligence Scale for Children (Wechsler, 1955) because of its widespread use with school children.

Sex Differences in Perceptual Development

Characteristically males tend to show slower development of perceptual skills than do females. Males were found to have greater difficulty with reading readiness tests (Carroll, 1948), to make up the majority of failing readers (de Hirsch, Jansky & Langford, 1966) and to make considerably more reversals (Fabian, 1945) than girls. Barrett's study (1964) examined the usefulness of visual discrimination tasks as predictors of first grade reading achievement and found sex differences in the effectiveness of the predictors used.

Males may experience slower development in auditory discrimination than do females. There is some evidence of slower articulatory development (Poole, 1934) which may accompany delayed discrimination. Illingworth (1970) considered that delayed language development is common in some families, but may be more prevalent in male children. Such maturational delays may occur as a result of slow development of part of the central nervous system.

Because of the generality of the finding that males show slower maturation of various skills, research studies of perceptual development should be controlled for sex ratios.

Conclusion: Patterns of Learning Abilities

There appears to be sufficient information in available research to allow postulations to be made on the existence and nature of certain patterns of learning abilities. These patterns appear to be based on underlying basal abilities and to manifest themselves in a range of behaviours which may be observed in school tasks and tests of intelligence.

(a) Visual Figure-Ground Pattern

The ability to fix attention volitionally on a specific visual stimulus while relegating all competing stimuli to the background and to change the focus of attention at will is a skill that is basic to the interpretation of all visual information. When it is poorly developed, there may be difficulty in interpreting pictures and in copying. Visual sequential memory may be poorly developed and the performance subtests on the Wechsler Intelligence Scale may show considerable scatter. Visual closure may be related to figure-ground differentiation.

(b) Auditory Discrimination Pattern

The ability to discriminate speech sounds is basic to learning speech and language. Poor discrimination may result in articulation errors, poor level of development of vocabulary and auditory memory, inadequate auditory closure and weak sound blending skills. The verbal subtest scores on the Wechsler Intelligence Scale for Children may show scatter.

(c) Spatial Pattern

The ability to understand the use of space may be basic to effective drawing and copying. There is research to suggest that the recognition of spatial relationships is important in learning arithmetic (MacFarlane Smith, 1964). The spatial pattern may be related to the figure-ground and/or sequencing patterns.

(d) Sequencing Pattern

Sequencing appears to be closely related to auditory and visual memories. De Hirsch (1967) defined sequencing as the ability to pattern events in time and space. Therefore, sequencing may include the spatial pattern and may influence the learning of arithmetic. Further research is needed to establish the nature of space and sequencing and how they relate to intellectual and academic tasks.

Sequencing may effect any tasks involving memory which on the Wechsler Intelligence Scale for Children might include the subtests of arithmetic, digit span and information.

(e) Vocabulary Pattern

Vocabulary is not considered as a basic perceptual ability. However, knowledge of word meaning appears to be related to some perceptual abilities as, for example, auditory discrimination (Elenbogen & Thompson, 1972). This study treated knowledge of word meanings as a predictor variable. The vocabulary pattern may include verbal subtests of the Wechsler Scales, part of reading readiness tests, auditory discrimination, auditory memory, sound blending and auditory closure.

The existence and nature of these patterns of learning abilities are highly conjectural as yet. However, if programming for children with learning difficulties is to be effective, specific deficits and groups of deficits must be isolated and their influence on the child's development examined as rigourously as possible.

CHAPTER III

SUMMARY OF RESEARCH, DEFINITIONS AND HYPOTHESES

Summary of Research

Auditory and visual abilities develop gradually and, in the pre-adolescent child, a wide range of abilities is regarded as normal. Generally, it is assumed that lags in the development of abilities may occur as a result of inadequate experience, central nervous system or other physiological deficit or may be within the lower level of the normal range of abilities. Regardless of its etiology, such a lag may predispose the child to various intellectual and learning difficulties. The relationships among certain auditory and visual learning abilities and early academic and intellectual development were investigated in this study.

Research, often done by reading specialists, has identified several perceptual abilities as important in the first years of school. Because of this, the subjects in this study were five and six years of age. Another reason for using young school children is the reported rapid decrease in the direct influence of perception on academic performance after the primary grades.

A number of visual and auditory learning abilities have been found to be related to early school progress. Auditory discrimination appears to be basic to the development of receptive and expressive language and has been related to reading, auditory memory and vocabulary. Auditory discrimination may influence auditory closure and sound blending, both of which have been linked to success in early

reading experiences. Auditory memory and sequencing have been found to be deficient in many children experiencing failure in reading. The relationship between auditory memory and auditory discrimination has not been clarified.

Vocabulary is an intrinsic part of language development. It appears that vocabulary, auditory memory and auditory discrimination are related, but this relationship requires further examination.

Figure-ground discrimination, visual closure, visual memory and the ability to recognize spatial relationships have been related to reading and arithmetic achievement. The degree of relationship appears to depend to a large extent on the age of the subjects studied. Generally the relationship is moderate in grades one and two but considerably weaker after grade three.

Copying appears to involve a complex of visual-motor skills. Overly optimistic claims have been made as to the diagnostic value of certain copying tests. As with other visual perceptual assessment techniques, the ability to copy at the age of five and six years seems to have a moderate relationship with future school achievement.

When an instrument tapping a wide range of visual and auditory skills is used, such as the Wechsler Intelligence Scale for Children, the most common finding is that poor readers tend to be deficient in verbal abilities. However, when a large number of children with reading problems are examined carefully, two groups appear to emerge, those who are low in verbal skills and those whose chief difficulties appear to be associated with visual tasks. Subtests requiring sequencing and memory may tend to be low in both the verbal and

performance areas. Despite its common use, little evidence is available on the role of perceptual abilities in the Wechsler Scales. This was examined in the present study.

The auditory and visual abilities mentioned above were assessed in this study and their relationships with each other, with Wechsler intelligence scores, with reading readiness and with early achievement in reading, arithmetic and spelling were investigated. Both males and females were included in the study to avoid a sex bias, in view of the common finding that males tend to mature more slowly than do females.

Definitions

(a) Achievement

This is the level of academic achievement as measured by a standardized test. The subtests of reading, arithmetic and spelling on the Stanford Achievement Test, Primary I (Kelley, Madden, Gardner & Rudman, 1964) were administered.

(b) Auditory and Visual Closure

Closure refers to the ability to recognize as complete a stimulus which is only partially presented. The Auditory and Visual Closure subtests of the Illinois Test of Psycholinguistic Abilities (Kirk & McCarthy, 1968) were used.

(c) Auditory Discrimination

This refers to the ability to differentiate between similar sounding auditory stimuli. The Goldman-Fristoe-Woodcock Test, quiet and noise subtests, (Goldman, Fristoe & Woodcock, 1970) was used.

(d) Auditory and Visual Sequential Memory - Nonmeaningful

Nonmeaningful sequential memory refers to the ability to remember the identity and order of presented symbols. The Auditory and Visual Sequential subtests of the Illinois Test of Psycholinguistic Abilities wers used.

(e) Auditory Memory - Meaningful

Meaningful auditory memory is the ability to recall sequences of words and sentences. The Auditory Attention Span for Related Syllables subtest from the Detroit Tests of Learning Aptitude (Baker & Leland, 1959) was used.

(f) Frostig Visual Perception Scores

The Frostig Developmental Test of Visual Perception (Frostig, Lefever & Whittlesey, 1963) is widely used in schools. It consists of five subtests purported to assess various visual perceptual abilities. Scores of the five subtests and the total Frostig test were used.

(g) Intelligence Scores

Intelligence was used to refer to the Verbal, Performance and Full Scale scores of the Wechsler Intelligence Scale for Children (Wechsler, 1955). All verbal subtests and all performance subtests except Mazes were administered.

(h) Readiness and Reading

Reading readiness scores were from the Metropolitan Readiness Tests (Hildreth, Griffith & McGauvran, 1965) The term reading

readiness was used to refer to the abilities needed for beginning reading, the first introduction to printed letters and words in grade one, while early reading was used to refer to reading in the primary grades.

(i) Sound Blending

This is the ability to blend sounds into meaningful words and may be an important skill in early reading (Hardy, Stennett & Smythe, 1973). In this study, it was assessed by using the Sound Blending subtest of the Illinois Test of Psycholinguistic Abilities.

(j) Spatial Relations

This refers to the ability to relate objects to each other in three dimensional or two dimensional space. The Ayres Space Test (Ayres, 1962) was used to assess spatial relations.

(k) Visual Figure-Ground Discrimination

Figure-ground discrimination is the ability to attend to a relevant stimulus in the presence of distracting background stimuli. It was assessed by using the Southern California Figure-ground Test (Ayres, 1966) and by the figure-ground subtest of the Frostig Developmental Test of Visual Perception.

(l) Vocabulary

Knowledge of word meanings is basic to verbal reception and expression and was assessed by the use of the Peabody Picture Vocabulary Test (Dunn, 1959). In the Peabody, the subject selects a picture to illustrate the word spoken by the examiner.

(m) Learning Ability

This term is used for any skill which apparently must be partially developed at least before a new and possibly more complex skill can be acquired. For example, a certain level of auditory discrimination, vocabulary and visual memory may be learning abilities required for reading. In turn, a knowledge of reading may be considered as a necessary learning ability for the mastery of social studies.

(n) Pattern of Learning Abilities

This term is used to describe two or more learning abilities which appear to be related beyond a chance level. A pattern of learning abilities may include perceptual, readiness, academic and intellectual skills.

Hypotheses

The review of related research did not lead to firm hypotheses. The postulates used as bases for investigation in this study might be described as expectations rather than as hypotheses. They served to summarize those relationships which appeared to be most likely on the basis of previous research, which had tended to examine relationships among relatively small numbers of abilities. In order to avoid overlooking significant relationships which might not have been examined in previous studies, a number of relationships in addition to those specifically hypothesized (i.e. expected) were examined in this study.

1. Relations of particular auditory and visual abilities with readiness, achievement and Wechsler scores.

The first section was concerned with identifying abilities which independently correlated to the greatest extent with subtest and total scores on the Metropolitan Readiness Tests, with grade one achievement in reading, arithmetic and spelling, and with subtest and total scores on the Wechsler Intelligence scale for Children. A division on the Metropolitan subtests was expected, with visual abilities related to the subtests of Matching, Numbers and Copying, and auditory abilities related to the Word Meaning and Listening subtests. It was expected that both auditory and visual abilities would be related to the Alphabet subtest.

In reviewing the literature, it appeared that auditory and visual memory, auditory discrimination and sound blending were closely associated with early reading, while spatial relations and possibly figure-ground discrimination were associated with arithmetic. It was expected that only visual abilities would be related to the Performance subtests of the Wechsler Scales and only auditory abilities would show relationships with the Verbal subtests.

To investigate these expectations the following statements were made. For statistical testing they were stated in null form.

1. (a) No auditory abilities assessed in this study have statistically significant relationships with reading readiness scores, grade one achievement scores or Wechsler intelligence scores.

1. (b) No visual abilities assessed in this study have statistically significant relationships with reading readiness scores, grade one achievement or Wechsler intelligence scores.

2. Relations of groups of predictors to criteria variables.

There is evidence from previous research that auditory and, to a lesser extent, visual abilities are important in early reading and intellectual development, while arithmetic appears to depend primarily on visual perception.

2. (a) Readiness tests such as the Metropolitan assess a number of areas which have been related to reading and arithmetic abilities. The auditory and visual abilities considered to be most related to school readiness were identified as those which should best predict the criterion variable of readiness as assessed by the Metropolitan Readiness Tests. For statistical testing, this was stated in the null form:

With the total readiness score as the criterion variable, the following are not important predictor variables: auditory discrimination, auditory memory, vocabulary, visual memory, figure-ground discrimination and spatial relations.

2. (b) There is evidence from previous research that certain auditory and visual abilities are related to success in early reading and it was expected that these should predict best the criterion variable of reading achievement. In null form:

With reading achievement as the criterion variable, the following are not important predictor variables: auditory memory, visual memory, vocabulary and auditory discrimination.

2. (c) Arithmetic ability has been related to understanding space and figure-ground discrimination has been considered as

necessary to spatial concepts. It was expected that these abilities would be the best predictor variables for arithmetic achievement. In null form:

With arithmetic achievement as the criterion variable, the following are not important predictor variables: spatial relations and figure-ground discrimination.

2. (d) The Wechsler verbal score has been related in previous research to knowledge of vocabulary which has, in turn, been related to auditory discrimination and auditory memory. It was expected that these abilities would be the best predictor variables for the Wechsler verbal score. In null form:

With the Wechsler verbal score as the criterion variable, the following are not important predictor variables: auditory memory, auditory discrimination and vocabulary.

2. (e) Clinical evidence and previous research suggested that the Wechsler performance score was related to visual abilities as well as to arithmetic achievement. It was expected that these abilities would be the best predictor variables for the Wechsler performance score. In null form:

With the Wechsler performance score as the criterion variable, the following are not important predictor variables: spatial relations and visual figure-ground discrimination.

3. Relations among particular auditory and visual tests, within and across modes.

At the present time there is insufficient information on the relationships among the tests used in this study. Clinical evidence

suggested that abilities such as visual figure-ground differentiation and spatial relations may be related to each other and to other visual measures. Previous research has shown that some tests of auditory discrimination, vocabulary and auditory memory showed relatively strong relationships with each other. There is only limited information on relationships between auditory and visual abilities. In this study, all relationships among the tests used were examined. For statistical testing, the following statements were made in the null form.

There are no statistically significant correlations among the results of the following predictor tests:

3. (a) All auditory tests.

3. (b) All visual tests.

3. (c) All auditory and visual tests.

4. Patterns of learning abilities.

Previous research indicated that certain abilities may be so strongly related as to form identifiable patterns of learning abilities. It was expected that the Wechsler performance scores would show strong relationships with certain visual abilities, the Wechsler verbal scores with certain auditory abilities, the arithmetic and copying scores with certain visual abilities and the total readiness scores with Wechsler verbal scores and certain auditory abilities. The patterns expected are given below, stated in the null form.

The following do not appear to form an identifiable pattern of learning abilities;

Pattern A - Wechsler performance, visual figure-ground discrimination, visual memory and visual closure scores.

Pattern B - Wechsler verbal, auditory discrimination, meaningful and nonmeaningful auditory memory, vocabulary, auditory closure and and sound blending scores.

Pattern C - arithmetic, copying and spatial relations scores.

Pattern D - total readiness, Wechsler verbal, auditory discrimination and vocabulary scores.

CHAPTER IV

INSTRUMENTS, SAMPLE, RESEARCH PROCEDURES AND LIMITATIONS

Instruments Used for Data Collection

A frequent problem in studies on perceptual development is confusing terminology, which is increased by a tendency for investigators to develop and use their own devices for measuring perceptual abilities. In this study, only commercially available, relatively standardized instruments, several of which are in common use in clinics and school systems, were used.

(a) Wechsler Intelligence Scale for Children

The Wechsler has been described as a well-standardized, stable instrument (Buros, 1965) and as the best available compendium of individually administered, subject comparison techniques purporting to measure intelligence (Buros, 1972). Two further considerations were important in selecting the Wechsler. It is in very common use and any information as to possible deficits which may be reflected in subtest scores should be useful. In certain circumstances, the Wechsler could be regarded as a screening device. Furthermore, in a study of visual and auditory abilities the Wechsler is highly suitable because of its division into verbal and performance subtests.

(b) Illinois Test of Psycholinguistic Abilities

The original experimental version of this test appeared in 1961 and was based on the communication model proposed by Osgood (1957).

The experimental edition led to extensive research and had considerable appeal for clinicians as it appeared to provide sufficient isolation of deficient abilities to allow for practical remedial suggestions. Several programs were developed to overcome deficits identified by the Illinois, for example, those of Karnes (1968) and Bush and Giles (1969).

Test-retest reliability for fifty-five six year old children is reported by the authors as being 0.70 for Visual Closure, 0.86 for Auditory Sequential, 0.38 for Visual Sequential, 0.71 for Auditory Closure and 0.42 for Sound Blending (Paraskevopoulous & Kirk, 1969).

The Illinois subtests used in this study, Visual and Auditory Closure, Visual and Auditory Sequential Memories and Sound Blending, were selected for specific reasons. The closure and sequential memory subtests appear to allow an estimation of an ability which appears in both the auditory and visual areas. Sequential memory appears to be an important skill in early reading and may be weak because of underlying perceptual problems. Perception and past learning may serve as a basis for closure. Sound blending appears to be important for success in phonetic word analysis and may be based to a considerable extent on auditory discrimination.

Like the Wechsler scales, the Illinois Test of Psycholinguistic Abilities is a familiar test to school psychologists, speech clinicians and reading specialists. Further information on its capacity to indicate underlying deficits may prove useful to diagnosticians and programmers.

(c) Peabody Picture Vocabulary Test

The Peabody, in common with most tests, is least reliable when used with young children, with a reported reliability of 0.67 at the

six year old level (Dunn, 1959). The standard error of measurement for intelligence scores at age six years is 8.61, which Dunn considers satisfactory.

Considerable information on the validity of the Peabody is given in the test manual. The words were selected from Webster's dictionary as able to be depicted with a picture. Individual words were selected when the percentage of subjects giving correct responses increased from one age group to the next. In comparing the Peabody with the Stanford-Binet (1960) vocabulary test, correlations ranged from 0.82 to 0.86, with a median of 0.83. Dunn noted that the Peabody tends to give the higher score. The Peabody and the Wechsler full scale scores correlated at a median level of 0.61, with Peabody and Wechsler Verbal at a median correlation of 0.67 and Peabody and Wechsler Performance at a median of 0.39. Information is included on the relationships between the Peabody and a number of school achievement tests.

The Peabody was selected for this study because it gives an estimate of the level of receptive vocabulary of a child without requiring expressive abilities. This may be an important consideration with children experiencing language difficulties.

(d) Metropolitan Readiness Tests

The Metropolitan tends to be highly regarded, partly because its authors included an extensive discussion on the interpretation of test results (Buros, 1972). The subtests include Word Meaning, Listening, Matching, Alphabet, Numbers and Copying. The authors discussed each of the subtests in terms of content validity. The Metropolitan

total score showed a correlation in the range of 0.70 with other readiness tests and in the range of 0.50 with the Stanford-Binet. In terms of predictive validity with the Stanford Achivement Test, Primary I, the correlation of the Metropolitan total score with the reading and arithmetic subtests was reported at about 0.67.

Reported reliability of the entire Metropolitan test by the split half method was above 0.90 and by alternate forms was found to be 0.91. The test is designed only for the child beginning formal schooling and test-retest reliability has not been investigated.

In summary, the Metropolitan appears to be a well-established readiness test and has the added advantage of use in the schools included in this study.

(e) Stanford Achievement Test - Primary I

The manual reported the following split half reliabilities; Word Reading 0.85, Paragraph Meaning 0.90 and Arithmetic 0.95. The authors stated the test was set up after an examination of appropriate courses of studies and texts, but that users of the test must determine subtest validity by comparing the questions with their own instructional objectives.

(f) Frostig Developmental Test of Visual Perception

The Frostig is made up of five subtests, 1) Eye motor co-ordination, 2) Figure-ground discrimination, 3) Form constancy, 4) Position in space, and 5) Spatial relations. A perceptual quotient can be obtained from the five subtest scores.

Test reliability was reported as not being especially high, as is often the case with tests for young children. Test-retest reliability

with a two week interval ranged from 0.42 to 0.80 for the various subtests, with the reliability of the perceptual quotient at 0.80. By the split-half method, reliability with children of ages five and six years ranged from 0.59 to 0.93 for the subtests, and was 0.89 for the perceptual quotient, as reported by the authors.

Studies of the validity of the Frostig have had varying results (Olson, 1966). Results of factor analytic studies indicate that the Frostig is a single factor test for children through grade two, with an additional factor emerging after grade two. Therefore, the subtest divisions may provide no useful differential discrimination (Buros, 1972).

The Frostig test was selected for this study because it is in common use by school personnel and it appears to be useful, at least at the grade one and two level, in estimating the child's ability to do certain two-dimensional perceptual motor tasks.

(g) Goldman-Fristoe-Woodcock Test of Auditory Discrimination

This test has two parts. In the Quiet subtest, the subject responds to a recorded word by pointing to a picture. The same technique is used in the Noise subtest, but the word is presented against a background of school cafeteria sounds. The Noise subtest is considered by the authors to give an estimate of the ability to make auditory figure-ground distinctions.

Test-retest reliability over a two week interval was established by the authors with a group of seventeen children. A test-retest correlation of 0.87 for the Quiet subtest and 0.81 for the Noise subtest

was achieved. By the split-half method, children from three to six years of age achieved a reliability correlation of 0.83 on the Quiet subtest and 0.61 on the Noise subtest.

The authors stated that the words used in the test are familiar and meaningful for young subjects, but a question arises as to the role of intelligence in the interpretation of the pictures (Buros, 1972).

The authors assessed concurrent validity by comparing classifications of "good" and "poor" discrimination made on the test with those made by experienced clinicians. The correlation between the two estimates was 0.76. While more data on reliability and validity are available than is the case with most tests of auditory discrimination, more evidence of the test's validity is needed (Buros, 1972).

This test is not well known as yet, especially in comparison with the Wepman Test of Auditory Discrimination. It was selected for this study for two reasons. First it was hoped that the Noise subtest would give useful information, although this did not occur. In this study only slight differences were observed between the results of the Silent and Noise subtests and no patterns of differences were noted. Therefore, the results of both subtests were treated as undifferentiated auditory discrimination scores. The second reason for selecting this test was the need for a picture test as many young children do not understand that words can sound the same or can sound different and this concept is necessary if meaningful responses are to be made to a test such as the Wepman.

(h) Detroit Tests of Learning Aptitudes

The Detroit is used frequently by reading specialists but there is almost no information available on it. Test-retest reliability was assessed by the authors after a five month interval and a "two or three year" interval and found to be 0.96 and 0.67 respectively. No estimates of validity have been made by the authors.

The Auditory Attention Span for Related Syllables subtest of the Detroit was selected for use in this study because it is a familiar test and is one of the very few tests of meaningful memory that has age norms.

(i) Ayres Space Test

This is a formboard type of test, with age norms from three to ten years. Internal consistency as measured by the author is high by the split-half method, 0.88 for five year old and 0.93 for six year old children. No test-retest information is given.

Standardization data appear to be inadequate, the author's claim that the test assists in identifying brain pathology appears to be unsubstantiated and this test is generally not well regarded (Buros, 1972). Despite these defects, this test was selected for use in the present study because it appears to draw upon an ability to conceptualize space while limiting motor response.

(j) Southern California Figure-Ground Visual Perception Test

This is an embedded figure type of test. The author gives no information on the sampling procedures used to standardize this test. Reliability reported by the author was unstable, ranging from 0.37 to

0.52 after a test-retest interval of one week. Validity data are not included. It was concluded that this test may have limited clinical usefulness because of the good body of test materials (Buros, 1972).

This test was used in this study partly because it was felt that an embedded figures test was needed to supplement the Frostig and partly because the test appeared to have a high discriminatory ability in a study reported by Ayres (1965).

The Sample

Possible subjects for the study were all children from the ages of five years six months to the ages of six years eleven months as of September first enrolled in normal grade one classes in the public school system of a large Canadian urban centre. Six schools were selected on the basis of their serving a mixed socio-economic population. Three of the schools were in older parts of the city and three were in newly developed areas which included expensive single family homes, apartments and government subsidized low-cost housing. All eighteen grade one teachers approached by their school principals consented to some of their pupils being included in the study.

Originally it was felt that an exploratory study should use subjects showing a wide range of abilities and that this might be done by examining the results of the Metropolitan Readiness Tests to find children who showed a spread in the auditory subtests of Word Meaning and Listening and in the visual-motor subtests of Matching and Copying. As an interim measure until the Metropolitan was administered, teachers were asked to select children whom they felt might be having difficulty in auditory or visual tasks or whom they would like included in the

study to obtain additional test information. The children referred by teachers showed a sufficiently wide spread of abilities that this method of identification was considered effective and there was no use of readiness scores as a criterion of selection.

(a) Selection of the Sample

One hundred thirty-seven children were referred by their teachers. As the assessment was done in three stages, perceptual, intellectual and achievement testing, there was a decrease in the number included at each stage. This decrease was caused by school transfers, absenteeism during assessment and, in two cases, exclusion from the sample because of grossly atypical interaction with the examiners. A further reduction in the sample size was made when it was decided to decrease the age spread of the children from seventeen to eleven months, including only those children from five years seven months to six years six months of age. The number of children included at each stage of the assessment is given in Table 1.

TABLE 1

Sample Size at Each Assessment Stage

Assessment Stage	Boys	Girls	Total
Perceptual	72	65	137
Intellectual	58	65	123
Achievement	58	54	112
Final Group	56	50	106

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]

It was possible to examine some of the characteristics of the final group of 106 subjects and the group originally referred by their teachers but dropped during the assessment period. An examination of Table 2 shows the groups were comparable in Wechsler scores and in the number of males and females excluded from the final group. The age of the children excluded was slightly higher because of the age limits of the study. Only a few records were sufficiently precise to allow a Blishen (1958) socio-economic rating to be made. However, even with only a few Blishen ratings available, there was a considerable difference in the mean socio-economic ratings of the final group retained and those excluded from the study.

TABLE 2

Some Characteristics of Subjects Retained
in the Final Sample and Subjects Excluded

Characteristic	Retained for Sample			Excluded from Sample		
	Number	Range	Mean	Number	Range	Mean
Age in months	106	67-78	73	27	67-83	75
Sex - females	50			15		
- males	56			16		
Wechsler - verbal	106	65-131	98	17	85-116	98
- performance	106	79-131	105	17	87-128	103
- full scale	106	69-131	102	17	85-118	100
Blishen rating	47	29-76	46	11	19-49	33

(b) Characteristics of the Sample

The sample consisted of 106 grade one children, fifty girls and fifty-six boys, ranging in age from five years seven months to six years six months as of September first. All were enrolled in regular grade one classes for the first year. One child was receiving additional instruction one afternoon a week in a class for unusually able children. One child had a diagnosed moderate unilateral hearing loss. It was possible that three children might at some later time be considered for entrance into classes for educable mentally retarded children. None of the five children was judged to be sufficiently atypical of grade one classes to be excluded from the study.

Research Procedures

With the exceptions of the Frostig Developmental Test of Visual Perception, the Metropolitan Readiness Test and the Stanford Achievement Test, all assessment was individual. Assessment was done in three stages. The perceptual assessment was done in six weeks in September and October, the readiness test in October, the intellectual assessment in five weeks in November and December and the academic assessment in one week in late January. The readiness test was administered and scored by classroom teachers. Perceptual assessment and achievement tests were administered by a psychologist and three research assistants and were scored by the psychologist. Intellectual testing and scoring were done by the psychologist.

Statistical analysis of the data began by finding Pearson product-moment coefficients of correlation to investigate the relationships between individual perceptual scores and the

criteria variables and the relationships among the scores obtained on the perceptual tests themselves. A level of probability of 0.05 or less was accepted as statistically significant in this part of the study.

In investigating the effect of combinations of learning abilities on the criteria variables, statistical analysis was based on the technique of stepwise multiple regression analysis.

The examination for patterns of learning abilities was investigated by examining the correlation coefficients to find relationships among the variables.

Assumptions and Limitations of the Study

The subjects in this study cannot be considered as typical grade one students as most were selected by their teachers as possibly experiencing learning difficulties. There was no randomized sampling of subjects, classes or schools.

Because of the extent of the assessment done, the testing period was relatively long. For example, the first battery of tests, which included perceptual measures, took six weeks to administer. The first two months in grade one may be a period of extremely rapid perceptual development in young children. There does not seem to be a relatively simple way to correct for or even to identify the changes that may have occurred during the six week assessment period.

There were probably unidentified or unrecorded health problems, particularly in the areas of vision and hearing, among the children in the sample. It was not considered practical to do vision and hearing screening tests in view of the large amount of assessment required for

this study. The amount of both health information and data on socio-economic status available for this research was the same information available to the teachers.

The children who were available for only part of the assessment and who therefore had to be excluded from the final sample may have biased the sample slightly to a higher socio-economic level than was the level of the group originally referred by the teachers.

The treatment received by the subjects in their classrooms was in no way controlled or rated for this study. Casual observation revealed teaching techniques ranging from individualized prescriptive teaching to the "one group, one reader" type of approach. Therefore, the effect of a learning difficulty might have been minimal in one classroom but a major obstacle to learning in another.

There is little information available on several of the tests used, particularly the Detroit Tests of Learning Aptitude, the Ayres Space Test, the Southern California Figure-Ground Test and the Goldman-Fristoe-Woodcock Test of Auditory Discrimination. These tests were selected because of the difficulty in finding tests which measure learning abilities in five and six year old children.

In summary, the lack of randomization resulted because of the exploratory nature of the study and the lack of specificity in classifying the learning abilities of young school children. Because the assessment was extensive, it was also time consuming. Like much research, this was done in the context of ongoing classroom situations where the experiences provided for students varied greatly within and between schools.

CHAPTER V

RESULTS OF THE STUDY

In Chapter V, the results of the study are discussed and these results are summarized. The results are then discussed as they support the postulate of hierarchical skill development and an example of hierarchical skills in arithmetic is given. The relationship between this study and previous research in learning abilities is examined.

Sex Differences

Only slight sex differences were found in the results of the tests used in this study. Males were significantly higher than females on the Wechsler vocabulary, picture arrangement, verbal, performance, and full scale scores. Differences on other tests failed to achieve statistical significance. As these differences were considered as slight, the sexes were pooled in subsequent analyses.

1. Relationships of Particular Auditory and Visual Abilities With Readiness, Achievement and Wechsler Scores

Product moment coefficients of correlation were computed to examine the degree of relationship shown by auditory and by visual abilities with the criteria variables used in the study.

a) Auditory Abilities

The levels of relationships found between auditory skills and Metropolitan Readiness test scores are given in Table 3. Receptive vocabulary and the ability to repeat sentences showed significant correlations with all Metropolitan subtests, while all other auditory

TABLE 3

Coefficients of Correlation Between Auditory

Measures and Metropolitan Readiness Scores

	Auditory Discrimination (Silent)	Auditory Discrimination (Noise)	Sentence Repetition	Digit Repetition	Auditory Closure	Sound Blending	Receptive Vocabulary
Word Meaning	0.319*	0.222	0.486*	0.199	0.348*	0.297*	0.519*
Listening	0.364*	0.192	0.360*	0.273*	0.295*	0.090	0.409*
Matching	0.226	0.050	0.271*	0.173	0.261*	0.059	0.264*
Alphabet	0.158	0.288*	0.333*	0.354*	0.258*	0.249	0.383*
Numbers	0.424*	0.348*	0.568*	0.323*	0.478*	0.408*	0.498*
Copying	0.158	0.223	0.393*	0.258*	0.287*	0.162	0.371*
Total Score	0.437*	0.341*	0.595*	0.392*	0.469*	0.327*	0.591*

*Significance $\leqq 0.05$

abilities assessed show significant correlations with some of the Metropolitan subtests and with the total score.

Table 4 summarizes the levels of relationships found between auditory abilities and Stanford Achievement scores. Receptive vocabulary was significantly correlated with all Stanford subtests and sentence repetition correlated significantly with all except two subtests. Other auditory abilities showed generally smaller relationships with fewer Stanford subtests than were shown by receptive vocabulary and sentence repetition.

The levels of relationships found between the auditory abilities and Wechsler scores are summarized in Table 5. Sentence repetition was significantly related to the scores of all verbal subtests, two performance subtests and to Verbal, Performance and total scores. Receptive vocabulary showed significant relationships with the total score and with all verbal subtests except Digit Span. Other auditory measures showed more scattered relationships.

From these results it appeared that sentence repetition and receptive vocabulary had relatively strong relationships with the results of the Metropolitan Readiness, Stanford Achievement and Wechsler tests. The abilities of repeating sentences and understanding words appeared to generalize to other intellectual and academic abilities to a greater extent than did the other auditory abilities examined.

b) Visual Abilities

Table 6 summarizes the levels of relationships found between visual abilities and Metropolitan readiness scores. All visual measures except visual closure, the ability to recognize a whole when only a

TABLE 4

Coefficients of Correlation Between Auditory

Measures and Stanford Achievement Test Scores

	Auditory Discrimination (Silent)	Auditory Discrimination (Noise)	Sentence Repetition	Digit Repetition	Auditory Closure	Sound Blending	Receptive Vocabulary
Word Reading	0.187	0.308*	0.245	0.154	0.216	0.194	0.519*
Paragraph Meaning	0.266*	0.289*	0.338*	0.216	0.234	0.167	0.409*
Spelling	0.101	0.266*	0.332*	0.307*	0.136	0.377*	0.264*
Arithmetic - Measures	0.140	0.075	0.204	0.200	0.158	0.165	0.383*
Arithmetic - Problems	0.312*	0.098	0.529*	0.370*	0.290*	0.183	0.498*
Arithmetic - Numbers	0.160	0.133	0.374*	0.240	0.304*	0.250	0.371*
Arithmetic - Total	0.249	0.135	0.478*	0.338*	0.332*	0.257*	0.591*

*Significance $\leqq 0.05$

TABLE 5

Coefficients of Correlation Between Auditory

Measures and Wechsler Scores

	Auditory Discrimination (Silent)	Auditory Discrimination (Noise)	Sentence Repetition	Digit Repetition	Auditory Closure	Sound Blending	Receptive Vocabulary
Wechsler-Information	0.272*	0.215	0.528*	0.266*	0.372*	0.227	0.399*
Wechsler-Comprehension	0.249	0.065	0.493*	0.439*	0.247	0.273*	0.421*
Wechsler-Arithmetic	0.250	0.261*	0.502*	0.269*	0.301*	0.398*	0.295*
Wechsler-Similarities	0.369*	0.140	0.406*	0.203	0.267*	0.200	0.386*
Wechsler-Vocabulary	0.424*	0.334*	0.595*	0.309*	0.466*	0.362*	0.638*
Wechsler-Digit Span	0.329*	0.361*	0.610*	0.527*	0.387*	0.300*	0.251
Wechsler-Picture Completion	0.102	0.169	0.155	0.031	-0.005	0.068	0.195
Wechsler-Picture Arrangement	0.212	0.162	0.239	0.228	0.171	0.118	0.314*
Wechsler-Block Design	0.236	0.045	0.289*	0.338*	0.215	-0.027	0.302*
Wechsler-Object Assembly	0.250	0.212	0.318*	0.178	0.231	0.001	0.251
Wechsler-Coding	0.034	0.076	0.128	0.002	0.071	0.087	0.008
Wechsler-Verbal Score	0.432*	0.326*	0.699*	0.465*	0.444*	0.396*	0.511*
Wechsler-Performance Score	0.214	0.199	0.292*	0.207	0.147	0.007	0.234
Total Score	0.387*	0.312*	0.601*	0.409*	0.362*	0.251	0.452*

*Significance $\leqq 0.05$

TABLE 6

Coefficient of Correlation Between Visual

Measures and Metropolitan Readiness Scores

	Ayres Space	Southern California	Visual Memory	Visual Closure	Frostig Eye-Motor	Frostig Figure-Ground	Frostig Form Constancy	Frostig Positions In Space	Frostig Spatial Relations	Frostig Total
Word Meaning	0.250	0.265*	0.222	0.257*	0.268*	0.240	0.351*	0.330*	0.213	0.401*
Listening	0.246	0.145	0.190	0.225	0.161	0.330*	0.381*	0.369*	0.430*	0.335*
Matching	0.213	0.246	0.304*	0.201	0.166	0.268*	0.371*	0.431*	0.455*	0.319*
Alphabet	0.242	0.135	0.250	0.075	0.226	0.346*	0.435*	0.431*	0.510*	0.529*
Numbers	0.233	0.232	0.402*	0.221	0.285*	0.398*	0.498*	0.584*	0.591*	0.489*
Copying	0.251	0.243	0.251	0.128	0.372*	0.397*	0.447*	0.395*	0.519*	0.459*
Total	0.354*	0.299*	0.408*	0.253	0.369*	0.488*	0.611*	0.627*	0.689*	0.634*

*Significance $\leqq 0.05$

part is visible, were significantly correlated with the total Metropolitan score, while four of the five Frostig subtests were significantly correlated with most of the Metropolitan subtests. The last three Frostig subtests, shape recognition in a variety of contexts, rotated design comparison and copying a marble-board design, were related strongly to the Metropolitan subtests of Matching, Alphabet, Numbers and Copying, and to the total readiness score.

Table 7 summarizes the levels of relationship found between visual abilities and the Stanford Achievement scores. Correlations with achievement tended to be smaller than correlations with the readiness subtests. The strongest relationships again tended to be the last three Frostig subtests with Stanford arithmetic problems, numbers and total, and with Stanford spelling.

Table 8 summarizes the levels of relationship found between visual abilities and Wechsler scores. Certain performance subtests, particularly Block Design and Object Assembly, showed statistically significant correlations with several of the visual abilities. The last three Frostig subtests again showed relatively strong correlations with several performance subtests, as well as with the verbal subtests of Arithmetic and Digit Span.

The last three Frostig subtests appeared to resemble sentence repetition and receptive vocabulary in that they showed relatively strong relationships, in comparison with other visual tests, with scores on the Metropolitan Readiness, Stanford Achievement and Wechsler tests. Correlations of each of the last three Frostig subtests with a single criterion variable, for example, spelling, tended to be relatively

TABLE 7

Coefficients of Correlation Between Visual

Measures and Stanford Achievement Test Scores

	Ayres Space	Southern California	Visual Memory	Visual Closure	Frostig Eye-Motor	Frostig Figure-Ground	Frostig Form Constancy	Frostig Positions In Space	Frostig Spatial Relations	Frostig Total
Word Reading	0.127	-0.018	0.173	0.021	0.115	0.312*	0.277*	0.370*	0.278*	0.383*
Paragraph Meaning	0.186	0.174	0.143	0.100	0.174	0.308*	0.316*	0.271*	0.374*	0.295*
Spelling	0.138	0.045	0.275*	-0.011	0.178	0.246	0.333*	0.320*	0.357*	0.565*
Arithmetic-Measures	0.177	0.154	0.192	0.073	0.126	0.289*	0.168	0.187	0.252	0.149
Arithmetic-Problems	0.153	0.177	0.293*	0.189	0.162	0.224	0.338*	0.424*	0.437*	0.302*
Arithmetic-Numbers	0.248	0.101	0.228	0.247	0.306*	0.236	0.331*	0.375*	0.390*	0.303*
Arithmetic-Total	0.257*	0.168	0.294*	0.245	0.287*	0.296*	0.376*	0.435*	0.473*	0.342*

*Significance $\leqq 0.05$

TABLE 8

Coefficients of Correlation Between Visual

Measures and Wechsler Scores

	Ayres Space	Southern California	Visual Memory	Visual Closure	Frostig Eye-Motor	Frostig Figure-Ground	Frostig Form Constancy	Frostig Positions In Space	Frostig Spatial Relations	Frostig Total
Wechsler Information	0.157	0.213	0.157	0.255*	0.125	0.203	0.316*	0.342*	0.359*	0.291*
Compre-hension	0.342*	0.359*	0.160	0.241	0.218	0.174	0.268*	0.284*	0.198	0.280*
Arithmetic	0.291*	0.204	0.356*	0.209	0.241	0.277*	0.447*	0.380*	0.402*	0.453*
Similar-ities	0.301*	0.258*	0.157	0.327*	0.207	0.088	0.257*	0.156	0.209	0.178
Vocabulary	0.366*	0.219	0.103	0.188	0.165	0.161	0.233	0.255*	0.172	0.236
Digit Span	0.184	0.313*	0.389*	0.305*	0.206	0.232	0.415*	0.526*	0.477*	0.463*
Picture Completion	0.227	0.204	0.071	0.197	0.133	0.309*	0.115	0.269*	0.250	0.277*
Picture Arrangement	0.257*	0.219	0.160	0.233	0.180	0.216	0.228	0.309*	0.309*	0.310*
Block Design	0.391*	0.196	0.261*	0.258*	0.338*	0.398*	0.321*	0.403*	0.467*	0.406*
Object Assembly	0.283*	0.227	0.220	0.296*	0.088	0.445*	0.320*	0.379*	0.406*	0.343*
Coding	0.003	0.153	0.187	0.217	0.139	0.300*	0.192	0.325*	0.334*	0.267*
Verbal Score	0.363*	0.350*	0.273*	0.273*	0 232	0.242	0.415*	0.423*	0.333*	0.514*
Performance Score	0.291*	0.264*	0.292*	0.245	0.177	0.469*	0.325*	0.504*	0.460*	0.579*
Total Score	0.402*	0.368*	0.318*	0.292*	0.252	0.425*	0.450*	0.555*	0.476*	0.657*

*Significance $\leqq 0.05$

similar, indicating that these three subtests may tap the same ability. This ability might be described as spatial orientation, as it appears to involve recognition, recall, discrimination and reproduction of shapes and designs in various contexts and perspectives.

2. Relations of Groups of Predictors to Criteria Variables

The degree to which combinations of auditory and visual tests predicted achievement in reading readiness, academic achievement and intellectual development were examined. A stepwise multiple regression analysis was made and the results are given in Tables 9, 10 and 11.

a) Readiness Scores

It was expected that with the total readiness score as the criterion variable, auditory discrimination, auditory memory, vocabulary, figure-ground discrimination and spatial relations would be useful predictor variables. Seventy percent of the variability in total Metropolitan Readiness scores was accounted for by variations in scores for receptive vocabulary, sentence repetition and the two Frostig subtests assessing the ability to copy a marble-board design and the ability to compare rotated designs.

b) Reading Achievement

It was expected that with reading achievement as the criterion variable, auditory memory, visual memory, vocabulary and auditory discrimination would be important predictor variables. Reading achievement was assessed by two subtests on the Stanford test, Word Reading and Paragraph Meaning. Prediction for both reading subtests was low, with about twenty percent of the variance being accounted for. Predictors for Word Meaning were Frostig Position in Space subtest,

TABLE 9

Stepwise Multiple Regression Analysis

Prediction of Metropolitan Readiness Test Scores

Criterion Variable	Predictor Variables	F	Probability	Cumulative Percentage of Variance
Word Meaning	Receptive Vocabulary	38.43	0.00	26.98
	Sentence Repetition	9.68	0.00	33.26
	Frostig Eye-Motor	3.40	0.07	35.45
Listening	Frostig Spatial Relations	23.55	0.00	18.46
	Receptive Vocabulary	11.47	0.00	26.63
	Auditory Discrimination	3.42	0.07	29.01
Matching	Frostig Spatial Relations	27.17	0.00	20.71
	Frostig Position in Space	4.92	0.03	24.33
	Frostig Form Constancy	2.44	0.12	28.87
Alphabet	Frostig Spatial Relations	36.64	0.00	26.05
	Receptive Vocabulary	7.99	0.01	31.38
	Digit Repetition	5.12	0.03	34.66
	Frostig Form Constancy	3.26	0.07	36.70
Numbers	Frostig Spatial Relations	55.81	0.00	34.92
	Sentence Repetition	27.88	0.00	48.79
	Receptive Vocabulary	6.27	0.01	51.75
	Frostig Position in Space	4.70	0.03	53.89
	Auditory Closure	2.90	0.09	57.51
Copying	Frostig Spatial Relations	38.44	0.00	26.99
	Frostig Form Constancy	7.67	0.01	32.05
	Frostig Eye-Motor	5.35	0.02	35.43
	Receptive Vocabulary	3.73	0.06	37.73
Total Score	Frostig Spatial Relations	44.02	0.00	47.48
	Receptive Vocabulary	41.80	0.00	62.64
	Frostig Form Constancy	17.18	0.00	68.03
	Sentence Repetition	8.94	0.00	70.63
	Auditory Closure	3.32	0.07	71.57

TABLE 10

Stepwise Multiple Regression Analysis

Prediction of Stanford Achievement Scores

Criterion Variable	Predictor Variables	F	Probability	Cumulative Percentage of Variance
Word Reading	Frostig Position in Space Auditory Discrimination Receptive Vocabulary	16.43 5.32 2.60	0.00 0.02 0.11	13.67 17.91 19.95
Paragraph Meaning	Frostig Spatial Relations Receptive Vocabulary Sentence Repetition	16.93 6.38 1.94	0.00 0.01 0.17	14.00 19.02 20.53
Spelling	Sound Blending Frostig Spatial Relations Digit Repetition Frostig Form Constancy	17.24 9.12 4.98 1.82	0.00 0.00 0.03 0.18	14.22 21.20 24.86 26.19
Arithmetic-Measures	Receptive Vocabulary Frostig Figure-Ground	11.15 2.38	0.00 0.13	9.69 11.18
Arithmetic-Problems	Sentence Repetition Frostig Spatial Relations Frostig Position in Space	40.39 10.34 0.64	0.00 0.00 0.42	27.97 34.54 34.96
Arithmetic-Numbers	Frostig Spatial Relations Sentence Repetition Frostig Eye-Motor Frostig Form Constancy	18.71 7.72 3.77 1.06	0.00 0.01 0.05 0.31	15.25 21.15 23.97 24.76
Arithmetic-Total	Sentence Repetition Frostig Spatial Relations Frostig Position in Space	30.81 15.21 1.87	0.00 0.00 0.17	22.85 32.78 39.00

TABLE 11

Stepwise Multiple Regression Analysis

Prediction of Wechsler Test Scores

Criterion Variable	Predictor Variables	F	Probability	Cumulative Percentage of Variance
Information	Sentence Repetition	40.14	0.00	27.85
	Frostig Spatial Relations	4.42	0.04	30.81
	Receptive Vocabulary	2.06	0.15	32.18
Comprehension	Sentence Repetition	33.45	0.00	24.34
	Southern California Figure-Ground	6.88	0.01	29.07
	Ayres Space	4.96	0.03	32.36
	Digit Repetition	4.29	0.04	35.12
	Sound Blending	2.90	0.09	36.95
Arithmetic	Sentence Repetition	35.07	0.00	25.22
	Frostig Form Constancy	10.59	0.00	32.19
	Sound Blending	6.10	0.01	36.06
	Ayres Space	3.68	0.06	38.31
Similarities	Sentence Repetition	20.58	0.00	16.52
	Visual Closure	6.01	0.02	21.12
	Receptive Vocabulary	3.82	0.06	23.98
Vocabulary	Receptive Vocabulary	71.45	0.00	40.72
	Sentence Repetition	19.17	0.00	50.03
	Auditory Closure	5.16	0.03	52.43
	Sound Blending	3.52	0.06	53.14
Digit Span	Sentence Repetition	61.65	0.00	37.23
	Frostig Spatial Relations	13.05	0.00	44.27
	Digit Repetition	6.95	0.01	47.83
	Frostig Position in Space	4.59	0.03	50.10
	Auditory Discrimination	2.66	0.11	51.98
Picture Completion	Frostig Figure-Ground	11.00	0.00	9.57
	Frostig Position in Space	1.95	0.17	11.24
Picture Arrangement	Receptive Vocabulary	11.39	0.00	9.87
	Frostig Spatial Relations	5.81	0.02	14.68
	Frostig Position in Space	1.36	0.24	15.29
Block Design	Frostig Spatial Relations	28.95	0.00	21.77
	Ayres Space	12.15	0.00	30.03
	Digit Repetition	4.60	0.03	33.05
	Frostig Figure-Ground	5.57	0.02	36.54
	Frostig Eye-Motor	4.86	0.03	39.48
	Sentence Repetition	0.40	0.53	39.73
Object Assembly	Frostig Figure-Ground	25.69	0.00	19.81
	Sentence Repetition	10.82	0.00	27.74
	Ayres Space	2.87	0.09	29.42
Coding	Frostig Spatial Relations	13.04	0.00	11.14
	Frostig Position in Space	2.73	0.10	13.44
Verbal Score	Sentence Repetition	99.21	0.00	48.82
	Ayres Space	5.64	0.02	51.48
	Sound Blending	6.74	0.01	54.49
	Southern California Figure Ground	2.95	0.09	55.78
Performance Score	Frostig Position in Space	35.35	0.00	25.37
	Frostig Figure-Ground	9.17	0.00	31.47
	Ayres Space	5.06	0.03	34.71
	Frostig Spatial Relations	1.36	0.25	35.58
Total Score	Sentence Repetition	58.66	0.00	36.07
	Frostig Figure-Ground	27.67	0.00	49.60
	Ayres Space	7.37	0.01	53.00
	Frostig Position in Space	3.70	0.06	54.66

the ability to discriminate between partially rotated designs, and auditory discrimination. Predictors for Paragraph Meaning were Frostig Spatial Relations subtest, involving the copying of a marble-board design, and receptive vocabulary. The abilities of repeating digits and sentences and visual memory were not useful predictors for reading in this study.

c) Arithmetic Achievement

It was expected that with arithmetic as the criterion variable, spatial relations and figure-ground discrimination would be useful predictor variables. The predictor variables of sentence repetition and Frostig spatial relations accounted for about one-third of the variability in the total arithmetic score. Figure-ground discrimination was not a predictor variable at the .05 level of probability.

d) Wechsler Verbal Scores

It was expected that with the Wechsler verbal score as the criterion variable, auditory memory, auditory discrimination and vocabulary would be useful predictor variables. Prediction of the Wechsler verbal score was slightly over fifty percent. The best predictors were sentence repetition, the Ayres space test which assesses the ability to recognize rotated figures, and the ability to blend isolated sounds into meaningful words. Auditory discrimination and receptive vocabulary did not predict the Wechsler verbal score at a .05 level of probability. However, both auditory discrimination and receptive vocabulary showed a relatively high relationship with the ability to repeat sentences (Table 12) indicating that their lack of value as predictors might be attributable to the use of stepwise multiple regression analysis. It is possible that the exclusion of

TABLE 12

Coefficients of Correlation Among Auditory Tests

	Auditory Discrimination (Silent)	Auditory Discrimination (Noise)	Sentence Repetition	Digit Repetition	Auditory Closure	Sound Blending	Receptive Vocabulary
Auditory Discrimination (Silent)	1.00	(0.452)*	0.484*	0.353*	0.298*	0.179	0.459*
Auditory Discrimination (Noise)	(0.452)*	1.00	0.396*	0.129	0.272*	0.290*	0.358*
Sentence Repetition	0.484*	0.396*	1.00	0.587*	0.512*	0.378*	0.526*
Digit Repetition	0.353*	0.129	0.587*	1.00	0.198	0.154	0.253
Auditory Closure	0.298*	0.272*	0.512*	0.198	1.00	0.361*	0.333*
Sound Blending	0.179	0.290*	0.378*	0.154	0.361*	1.00	0.252
Receptive Vocabulary	0.459*	0.358*	0.526*	0.253	0.333*	0.252	1.00

Correlations between Goldman-Fristoe-Woodcock auditory discrimination subtests are bracketed.

*Significance $\leqq 0.05$

sentence repetition from the test battery might have allowed auditory discrimination and/or receptive vocabulary to emerge as useful predictors of the Wechsler verbal score.

e) Wechsler Performance Scores

It was expected that with the Wechsler performance score as the criterion variable, figure-ground discrimination and spatial relations would be useful predictor variables. Thirty-five percent of the variability of the Wechsler performance scores was accounted for by variability in the scores of Frostig Position in Space, the comparison of rotated designs, Frostig Figure-Ground, the discrimination of overlapping designs, and Ayres Space, the conceptualization of rotated figures. Frostig Spatial Relations was not a significant predictor at the .05 level of probability. Measures of spatial concepts and the ability to discriminate between overlapping designs appeared to have a considerable relationship with Wechsler performance scores.

There are difficulties in isolating useful predictors when the predictor variables themselves are correlated. However, in general, receptive vocabulary, sentence repetition and the last three Frostig subtests which appeared to assess spatial orientation skills, appeared to be the strongest predictors of most of the criteria variables. Other predictor variables such as auditory discrimination, sound blending, digit repetition, Frostig eye-motor co-ordination and the two tests of figure-ground differentiation appeared as useful predictors for only a few criteria.

3. Relationships Among Particular Auditory and Visual Tests Within and Across Modes

Here the relationships among the predictor variables were examined.

a) Auditory Tests

The correlations of the auditory tests with each other are given in Table 12. The ability to repeat sentences correlated significantly with all other auditory measures and showed a relatively strong relationship with digit repetition, receptive vocabulary, auditory closure and auditory discrimination. Receptive vocabulary showed a strong relationship with sentence repetition and auditory discrimination, and a slightly weaker but statistically significant relationship with auditory closure. Both sentence repetition and receptive vocabulary tended to show a generalized relationship with other auditory measures.

b) Visual Tests

Table 13 summarizes the relationships found among the visual tests. All visual measures correlated with various of the Frostig subtests. In general, the last three Frostig subtests showed relatively equivalent correlations with other visual skills, particularly with visual memory and visual closure.

c) Auditory and Visual Tests

Table 14 summarizes the relationships found between the auditory and visual perceptual tests. The last three Frostig subtests tended to show fairly similar relationships and moderate correlations with sentence repetition and receptive vocabulary. As the receptive

TABLE 13

Coefficients of Correlation Among Visual Tests

	Ayres Space	Southern California	Visual Memory	Visual Closure	Frostig Eye-Motor	Frostig Figure-Ground	Frostig Form Constancy	Frostig Positions in Space	Frostig Spatial Relations	Frostig Total
Ayres	1.00	0.191	0.183	0.250	0.226	0.162	0.261*	0.193	0.241	0.256*
Southern California	0.191	1.00	0.185	0.187	0.190	0.302*	0.251	0.245	0.339*	0.285*
Visual Memory	0.183	0.185	1.00	0.276*	0.158	0.313*	0.438*	0.480*	0.384*	0.450*
Visual Closure	0.250	0.187	0.276*	1.00	0.231	0.274*	0.284*	0.290*	0.315*	0.211
Frostig Eye-Motor	0.226	0.190	0.158	0.231	1.00	(0.255)*	(0.232)	(0.396)*	(0.355)*	(0.515)*
Frostig-Figure-Ground	0.162	0.302*	0.313*	0.274*	(0.255)*	1.00	(0.463)*	(0.510)*	(0.527)*	(0.607)*
Frostig Form Constancy	0.261*	0.251	0.438*	0.284*	(0.232)	(0.463)*	1.00	(0.483)*	(0.480)*	(0.643)*
Frostig Positions	0.193	0.245	0.480*	0.290*	(0.396)*	(0.510)*	(0.483)*	1.00	(0.617)*	(0.756)*
Frostig Relations	0.241	0.339*	0.384*	0.315*	(0.355)*	(0.525)*	(0.480)*	(0.617)*	1.00	(0.615)*
Frostig Total	0.256*	0.285*	0.450*	0.211	(0.515)*	(0.607)*	(0.643)*	(0.756)*	(0.615)*	1.00

Correlations between Frostig subtests are bracketed.

*Significance $\leqq 0.05$

TABLE 14

Coefficients of Correlation Between Auditory

and Visual Tests

	Auditory Discrimination (Silent)	Auditory Discrimination (Noise)	Sentence Repetition	Digit Repetition	Auditory Closure	Sound Blending	Receptive Vocabulary
Ayres Space	0.250	0.170	0.297*	0.208	0.209	-0.044	0.315*
Southern California Figure-Ground	0.193	0.049	0.308*	0.223	0.213	0.153	0.133
Visual Memory	0.281*	0.240	0.320*	0.253	0.025	0.217	0.274*
Visual Closure	0.281*	0.219	0.301*	0.192	0.075	0.052	0.292*
Frostig Eye-Motor	0.132	0.075	0.177	-0.062	0.176	0.338*	0.192
Frostig Figure-Ground	0.268*	0.173	0.098	0.064	0.129	0.111	0.326*
Frostig Form Constancy	0.331*	0.316*	0.412*	0.277*	0.249	0.250	0.355*
Frostig Positions in Space	0.350*	0.303*	0.485*	0.293*	0.328*	0.233	0.368*
Frostig Spatial Relations	0.271*	0.270*	0.378*	0.281*	0.329*	0.272*	0.323*
Frostig Total	0.298*	0.244	0.354*	0.210	0.221	0.255*	0.307*

*Significance $\leqq 0.05$

vocabulary test involves picture interpretation, this relationship was, perhaps, understandable. However, the basis for the relationship between the ability to repeat sentences and the ability to interpret spatial orientations is more difficult to determine. These tasks may tap some basic sequencing ability which extends into both the auditory and the visual areas.

Significant relationships existed between auditory and visual abilities assessed in this study. The auditory abilities of sentence repetition and receptive vocabulary showed significant correlations with most of the visual abilities, while the visual ability tapped by the Frostig spatial orientation subtests showed a number of statistically significant correlations with auditory abilities.

4. Patterns of Learning Abilities

This section was concerned with the identification of patterns of learning abilities which appeared to show relatively strong relationships in this study.

Pattern A

It was expected that Wechsler performance visual figure-ground discrimination, visual memory, and visual closure scores would form an identifiable pattern of learning abilities.

Figure 1 shows the abilities having a positive correlation of .300 or more with the criterion variable of Wechsler performance scores and with each other. The strongest relationships were among the Frostig spatial orientation subtests, Frostig figure-ground differentiation and Wechsler performance scores.

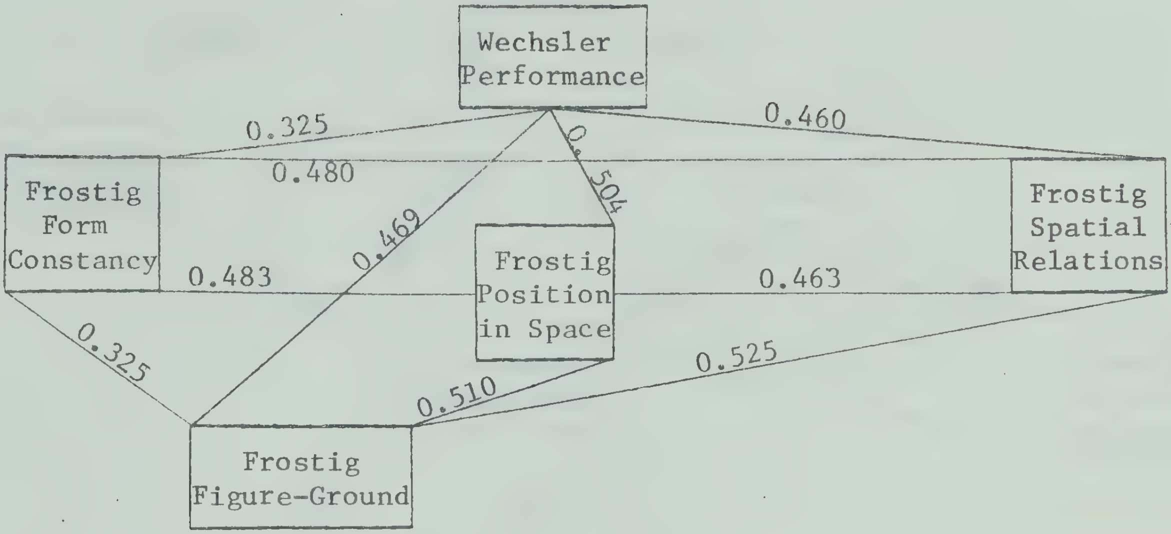


FIGURE 1

Largest Correlations for New Pattern A

Pattern B

It was expected that Wechsler verbal scores, auditory discrimination, meaningful and nonmeaningful auditory memory, vocabulary, auditory closure and sound blending would form an identifiable pattern of learning abilities. Some of these correlations were not statistically significant at the .05 level of probability, while some relatively strong relationships with visual tasks are not included. Figure 2 includes both auditory and visual relationships found to be at the level of .400 or higher. This level was selected to simplify Figure 2 by including only the stronger relationships.

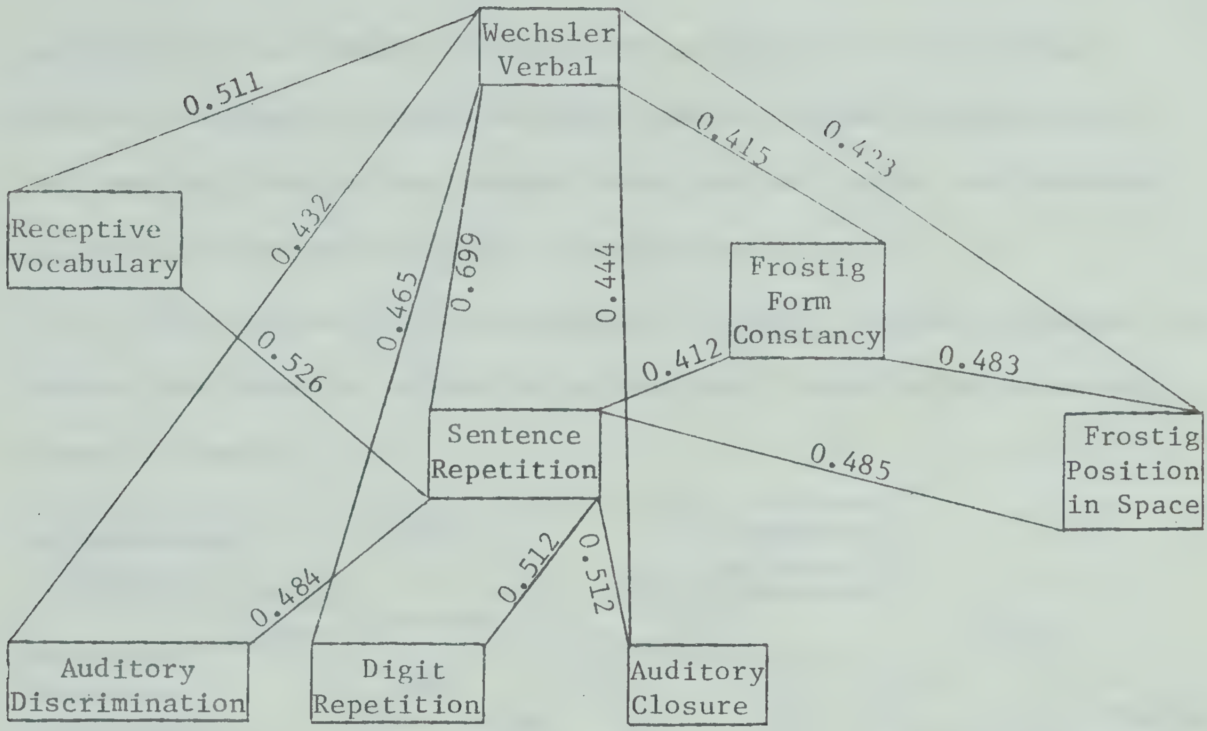


FIGURE 2

Largest Correlations for New Pattern B

Wechsler verbal scores were most strongly related to receptive vocabulary and sentence repetition which, in turn, showed a considerable relationship with each other. Auditory discrimination, digit repetition and auditory closure were related both to sentence repetition and to Wechsler verbal scores. Two of the three Frostig subtests subsumed under the term of spatial orientation showed significant relationships with sentence repetition and Wechsler verbal scores.

Pattern C

It was expected that arithmetic and Frostig spatial relations, the marble-board copying subtest, scores would form an identifiable pattern of learning abilities. While scores in Stanford arithmetic

and Metropolitan numbers showed higher correlations with Frostig spatial relations than with any other visual subtest (Tables 6 and 7), this was only part of the pattern found, as both visual and auditory abilities showed relationships with arithmetic.

The same skills correlated most strongly with both Metropolitan numbers and Stanford arithmetic total score. These correlations are given in Figure 3.

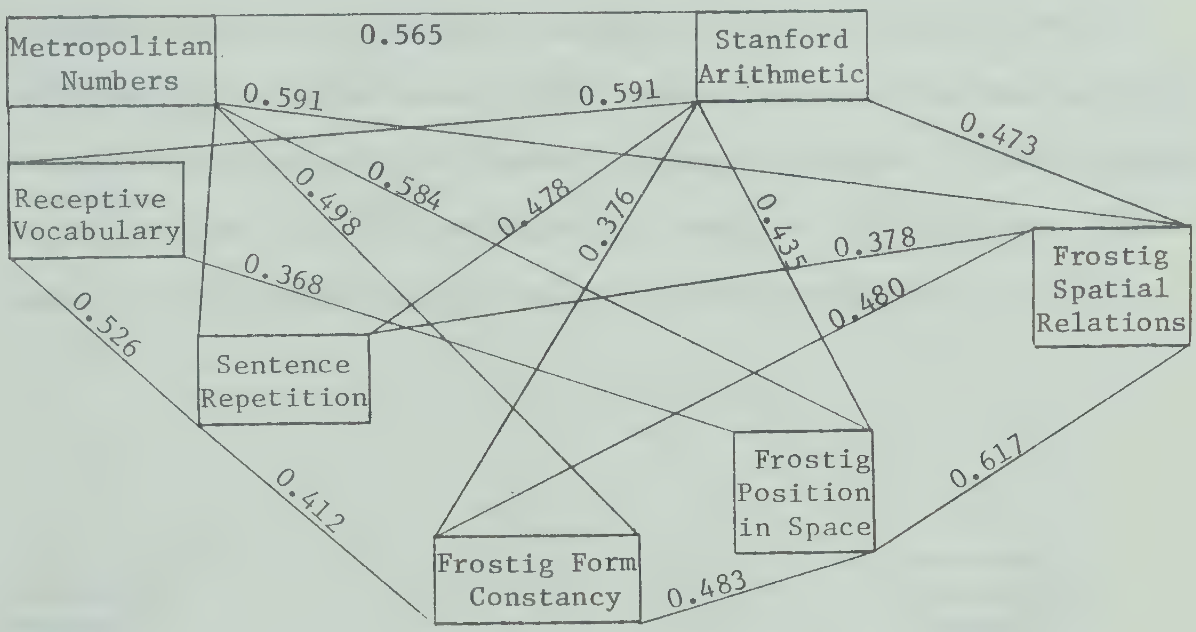


FIGURE 3

Abilities Showing Largest Correlations With Metropolitan Numbers and Stanford Arithmetic

The abilities showing the largest correlations with Metropolitan numbers and Stanford arithmetic were those which have been identified as general abilities, receptive vocabulary, sentence repetition and the three Frostig subtests tapping spatial orientation ability.

Pattern D

It was expected that Wechsler verbal, vocabulary, total readiness and auditory discrimination scores would form an identifiable pattern of learning abilities. Correlations for achievement, readiness and Wechsler test scores are included in Tables 15 and 16.

While these scores showed considerable correlation, the ability to repeat sentences was also highly correlated with total Metropolitan readiness, receptive vocabulary and Wechsler verbal scores. Total readiness scores showed considerable correlation with the three spatial orientation subtests of the Frostig. Figure 4 included all relationships in this pattern found to correlate at a level of .500 or higher. This level of relationship was used to reduce the complexity of the figure.

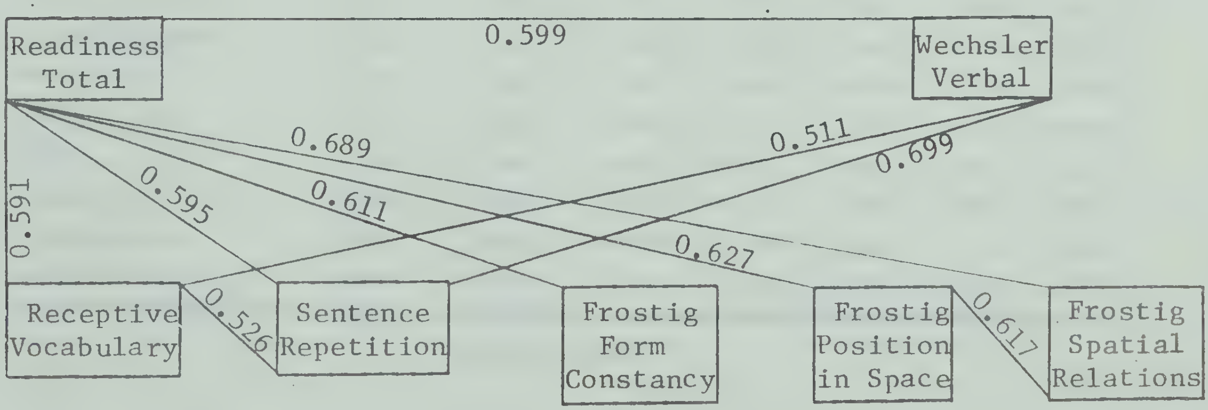


FIGURE 4

Largest Correlations for New Pattern D

TABLE 15

Coefficients of Correlation Between the Metropolitan Readiness and the Stanford Achievement and Wechsler Scores

Metropolitan Readiness	Word Meaning	Listening	Matching	Alphabet	Numbers	Copying	Total
Stanford Achievement –							
Word Reading	0.161	0.203	0.057	0.383*	0.323*	0.293*	0.371*
Paragraph Meaning	0.253	0.230	0.202	0.294*	0.359*	0.339*	0.430*
Spelling	0.190	0.139	0.196	0.425*	0.426*	0.407*	0.477*
Arithmetic-Measures	0.182	0.247	0.216	0.181	0.224	0.312*	0.331*
Arithmetic-Problems	0.294*	0.273*	0.437*	0.375*	0.562*	0.382*	0.575*
Arithmetic-Numbers	0.318*	0.299*	0.383*	0.352*	0.486*	0.375*	0.549*
Arithmetic-Total	0.346*	0.343*	0.448*	0.404*	0.565*	0.451*	0.632*
Wechsler –							
Information	0.422*	0.363*	0.263*	0.334*	0.438*	0.454*	0.575*
Comprehension	0.402*	0.209	0.171	0.220	0.243	0.184	0.342*
Arithmetic	0.429*	0.213	0.236	0.307*	0.447*	0.435*	0.514*
Similarities	0.432*	0.241	0.283*	0.287*	0.360*	0.147	0.422*
Vocabulary	0.535*	0.331*	0.177	0.281*	0.434*	0.195	0.468*
Digit Span	0.334*	0.220	0.216	0.413*	0.521*	0.290*	0.499*
Picture Completion	0.174	0.161	0.150	0.138	0.134	0.104	0.209
Picture Arrangement	0.236	0.268*	0.293*	0.363*	0.262*	0.264*	0.423*
Block Design	0.233	0.186	0.386*	0.329*	0.285*	0.501*	0.480*
Object Assembly	0.177	0.152	0.280*	0.236	0.318*	0.285*	0.360*
Coding	0.075	0.236	0.282*	0.158	0.193	0.046	0.241
Verbal Score	0.609*	0.358*	0.230	0.437*	0.499*	0.322*	0.599*
Performance Score	0.250	0.245	0.334*	0.378*	0.240	0.272*	0.429*
Full Scale Score	0.521*	0.362*	0.341*	0.492*	0.447*	0.358*	0.621*

*Significance $\leqq 0.05$

Coefficient of Correlation Between the Stanford Achievement

and Wechsler Scores

Stanford Achievement	Word Reading	Paragraph Meaning	Spelling	Arithmetic Measures	Arithmetic Problems	Arithmetic Numbers	Arithmetic Total
Wechsler							
Information	0.239	0.303*	0.279*	0.369*	0.391*	0.342*	0.440*
Comprehension	0.063	0.210	0.093	0.185	0.179	0.160	0.206
Arithmetic	0.331*	0.289*	0.359*	0.214	0.331*	0.375*	0.404*
Similarities	0.074	0.158	0.148	0.211	0.389*	0.241	0.342*
Vocabulary	0.177	0.259*	0.215	0.272*	0.277*	0.230	0.305*
Digit Span	0.301*	0.299*	0.363*	0.168	0.477*	0.351*	0.441*
Picture Completion	0.067	0.203	0.039	0.037	0.204	0.059	0.130
Picture Arrangement	0.312*	0.426*	0.296*	0.258*	0.272*	0.331*	0.376*
Block Design	0.219	0.219	0.228	0.350*	0.336*	0.343*	0.427*
Object Assembly	0.203	0.266*	0.091	0.268*	0.358*	0.269*	0.368*
Coding	0.030	0.058	-0.038	-0.110	0.318*	0.250	0.250
Verbal Score	0.282*	0.309*	0.320*	0.292*	0.407*	0.310*	0.409*
Performance Score	0.278*	0.292*	0.156	0.158	0.338*	0.249	0.325*
Total Score	0.335*	0.360*	0.291*	0.275*	0.447*	0.340*	0.445*

*Significance $\leqq 0.05$

Total readiness scores showed strongest relationships with Frostig spatial orientation. Readiness was also relatively highly correlated to receptive vocabulary, sentence repetition and Wechsler verbal scores.

Summary of the Results

There appeared to be three abilities which tended to be related extensively to the criteria variables examined in this study. These abilities were receptive vocabulary as assessed by the Peabody Picture Vocabulary test, sentence repetition as assessed by the Detroit Tests of Learning Aptitude and spatial orientation as assessed by the combined scores of the Frostig subtests of Form Constancy, Position in Space, and Spatial Relations. These abilities tended to show more and stronger relationships with the criteria variables than did the more specific basal abilities such as auditory discrimination, digit repetition and visual memory. The relationships which reached a coefficient of correlation of 0.400 or more are shown in Figure 5. Fisher transformations were made for the appropriate Frostig scores before a mean correlation for spatial orientation was found (Ferguson, 1966).

While the abilities of receptive vocabulary, sentence repetition and spatial orientation tended to relate broadly to the criteria variables, they also showed relationships with the basal abilities. This could reflect a structure in which a number of relatively specific basal abilities became integrated to form an integrated ability which becomes more directly related to criteria than were the component specific abilities. While some influences of the

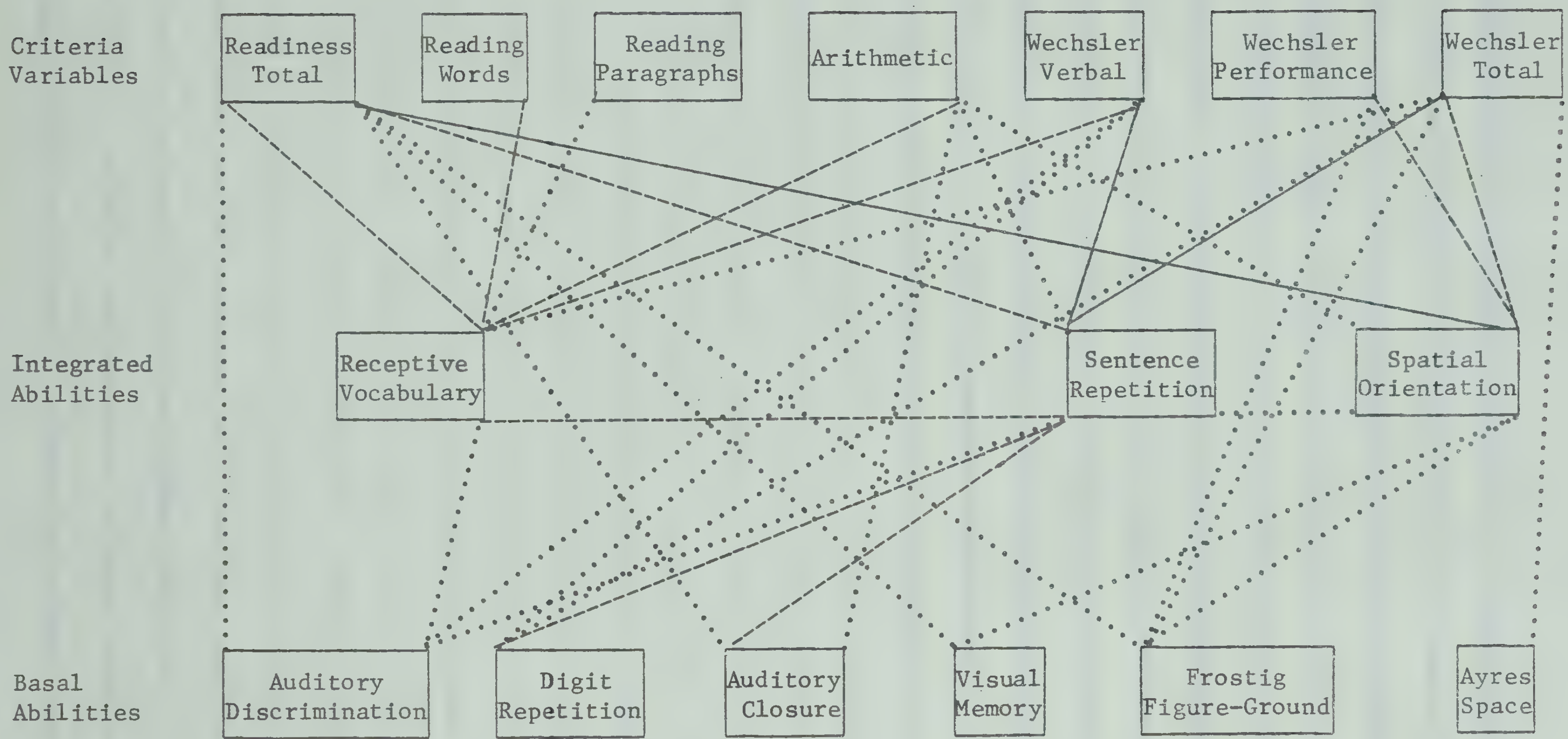


FIGURE 5

Relationships of Criteria Variables, Integrated Abilities and Basal Abilities

Coefficients of Correlation: ..... 0.400 to 0.499 ----- 0.500 to 0.599 ——— 0.600 to 0.699

basal abilities could still be detected, it might be more realistic to examine the influence of a basal ability, for example auditory discrimination, on the development of integrated abilities such as receptive vocabulary and sentence repetition, rather than to investigate its influence directly on criteria variables such as reading or intellectual development. It might be expected that at succeeding levels, abilities would show greater integration. For example, auditory discrimination may develop to a certain level, become integrated with auditory sequencing, auditory closure, vocabulary and other abilities not identified in this study, become strongly related to sentence repetition and again generalize through sentence repetition to a variety of academic and intellectual abilities. It seems reasonable to assume that such hierarchies of abilities may exist, with some or all components of the hierarchy changing in relation to the required task. The results of this study appeared to support such a hierarchical model.

For example, the data in this study were examined to determine the minimal levels of ability development shown by subjects successful in achieving a grade level in arithmetic of grade one five months or more by the standardized norms published in the manual for the Stanford Achievement Test. Minimum scores associated with this level of success in arithmetic for receptive vocabulary, sentence repetition and the subtests representing spatial orientation were found. The minimum scores found in the integrated abilities were used, in turn, to define a level to be used to determine minimum development of the basal abilities. In brief, the low scores in basal abilities were found for those subjects who scored at or above the minimal levels in the

integrated abilities which were found to be associated with success in the arithmetic subtest of the Stanford Achievement Test. This hierarchical structure is given in Figure 6. Raw scores and equivalent age scores as given in the test manuals are included.

Minimum raw scores were converted to age scores. For the integrated abilities, these were three years nine months for sentence repetition, five years seven months for receptive vocabulary and from five years no months to six years no months for the spatial orientation subtests. The low scores for basal abilities found to be associated with minimum and better development of the integrated abilities ranged from three years five months to three years seven months.

The Study in Relation to Previous Research

The results of this study were not directly comparable to the research included in the survey of the literature for a number of reasons. This study was designed to include subjects within a narrow age range from 67 to 78 months, to assess a number of auditory and visual skills and to investigate relationships among predictor variables as well as between predictor and criteria variables. The de Hirsch, Jansky and Langford (1966) study used subjects at this age range and a number of predictor variables but did not examine possible relationships among the predictors. Rosner (1973) examined subjects in grades one and two on only one visual and one auditory area. Golden and Steiner (1969) used a limited test battery with grade two children. Sabatino (1968) and Sabatino and Hayden (1970) used more extensive batteries but an age range of six and nine years respectively.

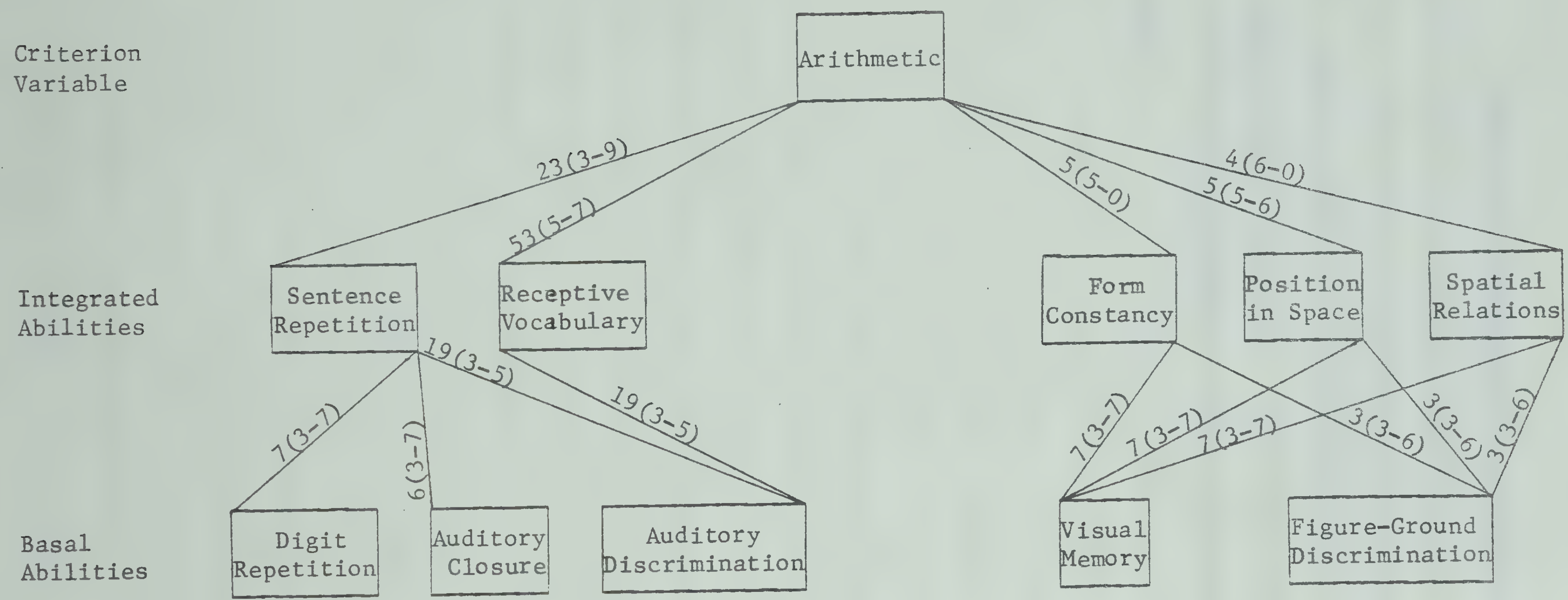


FIGURE 6

Minimum Levels of Integrated Ability Development Associated With

Arithmetic Achievement At Or Above Grade Level and

Minimum Basal Ability Development Associated With Integrated Ability Development

Because of differences in the age ranges of subjects, the extent of the areas assessed and the design for the examination of the data, a comparison of the results of the present study with those of the studies included in the survey of related literature appears to be inappropriate. In general, the studies included served as a basis for determining the assessment areas to be investigated in the present study.

CHAPTER VI

SUMMARY AND DISCUSSION OF THE STUDY

Summary of the Study

The development of techniques purporting to assess learning abilities in children appears to allow for more specific study of child development than was possible when tests were designed solely to measure intellectual and academic achievement. It is possible that learning ability tests may provide considerable information on the components of complex tests such as those used to assess intellectual development and reading and arithmetic skills.

Previous research studies have found relationships between reading and the following learning abilities, auditory discrimination, auditory and visual closure, sound blending, meaningful and nonmeaningful auditory memory, vocabulary, figure-ground discrimination and visual memory. Studies on the relationships between reading achievement and verbal and performance scores on the Wechsler Intelligence Scale for Children have shown that a majority of children with reading difficulties tended to have lower verbal than performance scores, while a minority of poor readers had lower performance than verbal scores. Some studies have found statistically significant relationships between some visual abilities and achievement on various nonverbal intelligence tests. Sex differences have been observed in the development of learning abilities, with females generally showing more rapid development than is typical of males.

In the present study, fifty girls and fifty-six boys ranging in age from sixty-seven months to seventy-eight months and attending regular grade one classes in the public school system of a large Canadian urban centre were selected by their teachers as possibly experiencing learning difficulties. The numbers of males and females included were relatively even to avoid introducing a sex bias into the study. To determine whether males and females should be considered as separate groups, the relationship between sex and test scores was considered. Wechsler vocabulary, picture arrangement, verbal, performance and full scale scores were slightly but significantly related to sex and, in all cases, favoured the male part of the sample. This may reflect a tendency of teachers to perceive female but not male pupils with certain intellectual deficits as having learning difficulties.

The range in chronological age was eleven months. Despite this narrow range, age was found to be statistically significant in the scores in visual closure, Frostig spatial relations, Metropolitan matching and numbers, Stanford arithmetic problems and Stanford arithmetic total. In no case was age the most significant predictor variable.

The effects of sex and age appeared to be limited sufficiently to allow the sample to be treated as one group, without subdividing it.

The subjects ranged in Wechsler full scale scores from 69 to 131 with a mean score of 102. Subjects were drawn from a variety of socioeconomic backgrounds. While not all subjects could be placed on the Blishen Scale, those who were categorized on this scale ranged from ratings of 29 to 76.

The auditory and visual abilities mentioned here as having been related to reading were examined in this study and their relationships with each other, with reading readiness, with early achievement in reading, arithmetic and spelling, and with Wechsler intelligence scores were investigated.

Criteria tests used in this study were the Metropolitan Readiness Tests assessing reading readiness, the Stanford Achievement Test, Primary I to assess reading, spelling and arithmetic achievement after five months in grade one, and the Wechsler Intelligence Test for Children for verbal, performance and full scale scores.

Auditory and visual ability tests used included several subtests from the Illinois Test of Psycholinguistic Abilities, auditory sequential memory to assess digit repetition, visual sequential memory, auditory and visual closure and sound blending. Auditory discrimination was assessed by using the Goldman-Fristoe-Woodcock Test of Auditory Discrimination, sentence repetition was assessed by using the Memory for Related Syllables subtest of the Detroit Tests of Learning Aptitudes and receptive vocabulary by the Peabody Picture Vocabulary Test. All subtests of the Frostig Developmental Test of Visual Perception as well as the Ayres Space Test and the Southern California Test of Figure-Ground were used to assess visual abilities.

Coefficients of correlation were found for the relationships between predictor and criteria variables. Stepwise multiple regression analysis was used to investigate the level of prediction of the criteria variables from the predictor variables. Coefficients of correlation

were found for the relationships among the predictor variables and, finally, an attempt was made to determine if patterns of abilities appeared to be indicated from the results of the study.

When the results of the study were examined, two major areas tended to emerge. One area centered on the identification of useful predictors of the criteria variables used, while the second area centered on the patterns of relationships found among predictor and criteria variables.

(a) <u>Prediction of Criteria Variables</u>

This consisted of the identification of the most useful predictors among the auditory and visual subtests for the criteria variables of reading, spelling, arithmetic, Wechsler verbal and performance scores, and total readiness scores.

The predictor variables used were most effective in predicting total readiness scores, with variability in the scores for two Frostig subtests, for receptive vocabulary and for sentence repetition accounting for seventy percent of the variation in total readiness scores.

Prediction of Wechsler verbal scores from these predictor variables was more effective than prediction of Wechsler performance scores. Variability in the scores for sentence repetition, the Ayres space test and sound blending accounted for fifty-four percent of the variation in Wechsler verbal scores, while variability in the scores for two of the Frostig subtests and the Ayres space test accounted for about thirty-five percent of the variation in Wechsler performance scores.

The predictor variables used were less effective in predicting early school achievement than they were in predicting readiness and Wechsler scores. Variability in the scores for sentence repetition and one Frostig subtest accounted for about thirty-three percent of the variation in arithmetic scores. Variability in the scores for sound blending, one Frostig subtest and digit repetition accounted for twenty-five percent of the variation in spelling achievement. Prediction of reading achievement from the predictor variables was relatively weak, with only eighteen percent of the variability in Stanford Word Meaning being accounted for by variation in the scores of one Frostig subtest and auditory discrimination, while nineteen percent of the variability in Stanford Paragraph Meaning was accounted for by variation in scores for one Frostig subtest and receptive vocabulary.

Prediction of readiness scores and Wechsler verbal scores from the predictor variables used was relatively strong, prediction of Wechsler performance scores and Stanford arithmetic was moderate, while prediction of early reading achievement was relatively weak. Reading appeared to require an unknown number of abilities which were not assessed in this study.

(b) Relationships Among Variables

First, coefficients of correlations among the predictor variables and between predictor and criteria variables were found. Two levels of ability development among the predictor variables were tentatively identified in this study. The first level of abilities, called the basal abilities, tended to be rather weak and limited

[illegible]

predictors of the criteria variables, but showed fairly strong relationships with the next level, called here the integrated abilities. The basal abilities identified in this study were auditory discrimination, the ability to differentiate similar speech sounds, auditory and visual memories, the ability to reproduce sequences of nonmeaningful auditory and visual stimuli, auditory closure, the ability to perceive parts of spoken words as whole and figure-ground discrimination as assessed by the Frostig subtest, the ability to attend to only parts of ambiguous visual stimuli, while relegating irrelevant parts to the background.

While the basal abilities had some usefulness in predicting the criteria variables, the best general predictors were the integrated abilities of receptive vocabulary, sentence repetition and spatial orientation as assessed by the Frostig subtests of Form Constancy, Position in Space and Spatial Relations which involve recognition, recall, discrimination and reproduction of shapes and designs in various contexts and perspectives. Spatial orientation was related to the basal abilities of visual memory and of attending to only relevant parts of ambiguous visual stimuli. The auditory integrated abilities of receptive vocabulary and sentence repetition showed a relatively strong relationship with each other and both were related to the ability of differentiating similar speech sounds. However, only sentence repetition showed moderately strong relationships with digit repetition and with the ability to perceive a partial word as a whole. There was also a relatively stronger relationship between

spatial orientation and sentence repetition, indicating an ability common both to concepts of space and concepts of recalling meaningful auditory sequences.

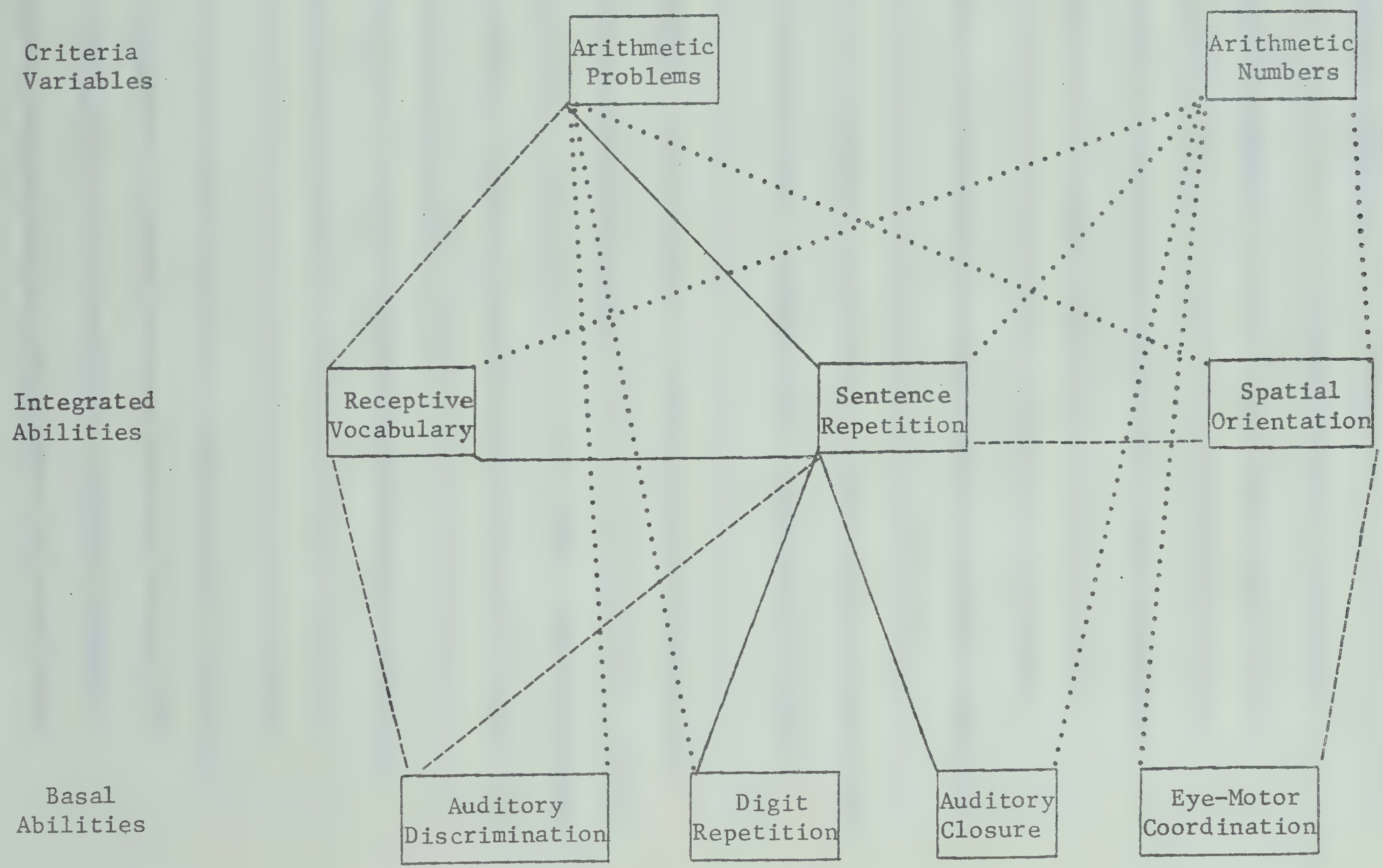
Next an examination was made of the coefficients of correlation among all variables to investigate possible patterns of learning abilities. It was postulated from the data examined in this study that the abilities categorized here as criteria variables depended upon the underlying development of various hierarchies of basal and integrated abilities, with the integrated abilities showing the clearer relationships with criteria variables. It was further postulated that the development of the integrated abilities depended to an extent on certain levels of development having occurred in the basal abilities. The nature and relative influence of basal and integrated abilities found in a particular hierarchy appeared to depend upon the criteria variable, with components of the hierarchy changing in response to the demands of particular criteria variables.

An example of this change in hierarchical components is given in Figure 7. The criteria variables were the subtests of Arithmetic Problems and Arithmetic Numbers from the Stanford Achievement Primary I arithmetic test. Arithmetic Problems showed stronger relationships than Arithmetic Numbers with the integrated abilities of sentence repetition and receptive vocabulary. There were differences between the arithmetic subtests in the direct relationships shown with basal abilities. Arithmetic Problems showed statistically significant relationships with digit repetition and auditory discrimination, while Arithmetic Numbers was related to auditory closure and eye-motor

FIGURE 7

Hierarchical Components of Two Stanford Achievement Arithmetic Subtests

Coefficients of Correlation: .....0.300 to 0.399 ---0.400 to 0.499 ——0.500 to 0.599



coordination. While both arithmetic subtests were related to integrated and basal abilities, the strength of relationships and the identity of the basal abilities were not identical, indicating slightly different components for the hierarchical structure of abilities required by the two subtests. It might be noted that Figure 7 illustrates the postulate made in this study that basal abilities tend to show stronger relationships with integrated abilities than they show with criteria variables. For example, auditory closure is relatively strongly related to sentence repetition and more weakly related to arithmetic numbers, while auditory discrimination shows moderate relationships with receptive vocabulary and sentence repetition, and a weaker relationship with arithmetic problems.

In summary, the abilities of sentence repetition, receptive vocabulary and spatial orientation were found to be relatively strongly related to the criteria variables used in this study. Other abilities investigated tended to be more strongly related to sentence repetition, receptive vocabulary and spatial orientation than to the criteria variables. From this, it was postulated that sentence repetition, receptive vocabulary and spatial orientation might be integrated abilities, with their development based in part on the previous development of certain basal abilities. A hierarchical structure of abilities was suggested in which basal abilities influenced the development of integrated abilities which, in turn, influenced criteria variables such as academic achievement and intellectual development.

Discussion of the Study

a) The Hierarchical Structure

Previous research suggested that ability structures might exist, based on the development of the abilities of visual figure-ground discrimination, auditory discrimination, spatial relations and vocabulary. It was expected that clusters of abilities both at the criteria and predictor levels might be found which would center on the development of these four abilities. This clustering effect was not found. Instead, a hierarchical model appeared to emerge from the data, with the predictor variables themselves dividing into two levels, called here the basal level of abilities and the integrated level of abilities.

The basal abilities, consisting of auditory discrimination, digit repetition, auditory closure, the Frostig figure-ground subtest and the Ayres space test, were found to have the most limited relationships with each other, rather less limited relationships with criteria variables and their strongest relationships with the integrated abilities (Figure 5). In turn, the integrated abilities of receptive vocabulary, sentence repetition and spatial orientation were found to have stronger relationships with both criteria variables and basal abilities than were found between criteria variables and basal abilities.

From these findings, it was postulated that a hierarchical structure of abilities might exist, with each level subsuming a number of underlying abilities and changing their nature by combining them to form increasingly complex abilities. Although the two groupings of abilities described in this study were called basal and integrated,

it appears possible that these are higher complexes of behaviours which might be assumed to have earlier manifestations in the behaviours of early infancy. However, for the purposes of educators, it may be sufficient to enter the hierarchical structure at the pre-readiness level, which might be at a developmental age of about four or five years. The battery of assessment techniques used in this study appeared to be adequate at this level, as it was possible to predict seventy percent of the variation in the total readiness scores from variation among the predictor variables used. An earlier entry into the ability hierarchy might be needed for extensive preschool preventive programming. This might require new instrumentation and a considerable amount of research on normal learning and appropriate intervention techniques at the age two or three year level. The age levels mentioned are based on the assumption that in working with preschool children, it is necessary to classify behaviours which are at least two years behind the chronological ages of the children being assessed.

It might be noted that the hierarchical structure developed in this study is somewhat similar to the model used in the Illinois Test of Psycholinguistic Abilities based on Osgood's (1957) model of communication processes. The I.T.P.A. subtests used in this study are among those classified by Kirk, McCarthy and Kirk (1968) as automatic abilities and are included among the basal abilities described in this study. None of the representational subtests of the I.T.P.A. was used, but these may be similar in their relationships with criteria variables to the integrated abilities described in this study. The study might be replicated and the representational subtests of the I.T.P.A. included.

b) Implications of the Hierarchical Structure for Assessment

Preschool children who appear to have developmental anomalies in various areas typically are identified on simple screening devices such as the Denver Developmental Screening Test (Frankenburg & Dodds, 1967) and similar instruments. These appear adequate in selecting groups of children in risk of developing learning problems, but deficits may have to be identified more specifically if suitable programs are to be established. Preschool or early grade one screening techniques might include tests for receptive vocabulary, sentence repetition and spatial orientation, along with observations of gross and fine motor coordination. Articulation can be observed during the sentence repetition assessment. This simple screening can be done by a classroom teacher or aide in a few minutes, after limited training. Where an integrated ability has been found to be poorly developed, basal abilities associated with it could be assessed further. This would avoid the administration of lengthy batteries to assess basal abilities which appeared, in this study, to show only limited direct relationships with the criteria examined. This approach takes into account two levels of ability, the integrated and the basal levels.

In some cases, the third level of behaviour observations which are called the criteria variables in this study may be available. The Metropolitan Readiness Test is used widely and might be considered as an indication that further assessment should be done. For example, when a child receives a relatively low score in the Word Meaning subtest, evaluation of his abilities in receptive vocabulary and sentence repetition may indicate an underlying difficulty in one or

[illegible]

both of these areas. Similarly, all three integrated abilities might be evaluated when the subtest of Numbers or the total score is considered low. Following the identification of weaknesses in the integrated abilities, the more strongly related basal abilities could be assessed.

In summary, in using a hierarchical structure to select assessment techniques, the examiner might use tests which examine only the integrated abilities as a screening battery, before proceeding on to examine the basal abilities which appear to underlie the development of the integrated abilities and, through them, the criteria variables with which he ultimately is concerned.

c) Implications of the Hierarchical Structure for Program Development

In this study, basal abilities appeared to be related minimally to criteria variables, but were more closely related to integrated abilities. In turn, the integrated abilities appeared to influence the development of a number of criteria variables. In developmental and remedial programming, it may be incorrect to assume that the development of a basal ability will lead directly to improved performance in criteria variables. For example, when poor auditory discrimination is noted, this ability can be developed with the hope that reading and arithmetic skills will improve. However, because of previous difficulty in discrimination, the child may have poor abilities in receptive vocabulary and meaningful memory, which also appear to be important in reading and arithmetic.

It may be equally incorrect to assume that an apparent improvement of an integrated ability without the improvement of deficient

underlying basal abilities will enable the child to use that integrated ability in the criteria variables. For example, when poor ability in sentence repetition is noted, this ability may appear to improve after the child has practice in repeating sentences. His sequencing ability may improve to some extent, but if he has weak development in receptive vocabulary and/or auditory discrimination, he may not be able to use this ability properly when he fails to understand the words used.

When a weakness in either a basal or an integrated ability is noted, it may be appropriate to determine which related abilities are weak and to program to develop the inadequate basal abilities before working directly on the integrated abilities. For example, the child with poor development in auditory discrimination, receptive vocabulary and sentence repetition may require considerable programming in the discrimination of speech sounds before he can understand words and recall word sequences. Otherwise ability development may be splintered with the development of the integrated abilities limited to a relatively superficial level.

An example of this approach to remedial/developmental assessment and programming which aims at identifying and programming for hierarchies of abilities is included in Appendix A in the form of a hypothetical case study.

d) Relationships Between Auditory and Visual Abilities

The design of this study allowed the examination of relationships between auditory and visual abilities. A number of statistically significant relationships were found and are shown in Table 14.

Relationships between visual abilities and the abilities of auditory discrimination and receptive vocabulary are to be expected, as the tests used require the correct interpretation of pictures. However, sentence repetition uses an auditory stimulus and requires an auditory response but showed a considerable number of statistically significant relationships with visual abilities. It was noted that the relationships shown between digit repetition and visual abilities tended to be smaller but to follow the same pattern as the relationships between sentence repetition and visual abilities. For example, both sentence repetition and digit repetition showed limited or no relationships with the Frostig subtests of eye-motor coordination and figure-ground differentiation, while both showed their strongest visual relationships with the last three Frostig subtests which make up the ability described in this study as spatial orientation.

Because of the similarity in the patterns of relationships shown both by sentence repetition and digit repetition, it was assumed that an ability found in both variables was involved and this would appear to be the ability to sequence auditory stimuli. Therefore, it appears necessary to question the nature of the relationship between auditory sequencing and visual abilities.

The visual subtest which showed the strongest relationship with auditory sequencing was the subtest which appears to assess the ability to retain a visual stimulus against distractors consisting of similar stimuli which have been rotated by varying numbers of degrees. This task appears to require a certain understanding of directionality which may be characterized by an understanding of the angle at which a stimulus

is presented and an orderly scanning of alternate stimuli to find one at the identical angle of the original. This orderly scanning may be based on an underlying ability of directional search which may also be a basis for the recall and orderly repetition of digits and sentences. De Hirsch (1967) referred to sequencing as the ability of patterning events in time and space. The relationships found in this study between sentence repetition, in particular, and visual abilities appear to lend evidence to an assumption that there is an ability common to both auditory-time and visual-space sequencing and that this ability may consist, at least in part, of an understanding of directionality.

e) Auditory and Visual Abilities in Grade One Standardized Tests

It appeared that the Metropolitan Readiness Tests were strongly related to visual abilities for the subjects in this study (Table 9). Only seven of the predictors used were useful in that they increased prediction at less than a .05 level of probability and of these only two were auditory, while the five useful visual predictors were the five Frostig subtests.

In contrast to the limited number of useful predictors for the Metropolitan, there were fourteen useful predictors for the Wechsler scores (Table 10). All the auditory and visual abilities assessed except visual memory were useful predictors of various subtests of the Wechsler Scale. The Wechsler appeared to draw upon a much broader range of abilities and to contain a considerably stronger auditory component than did the Metropolitan.

Prediction of Stanford Achievement scores (Table 11) was considerably weaker than prediction of the Metropolitan and Wechsler scores. Nine predictors were useful and of these five were auditory and four were visual predictors.

If these observations can be generalized, it appeared that the Metropolitan Readiness Tests tended to overemphasize visual abilities, which might lead to children appearing to be performing well on readiness tests but, because of unnoticed auditory deficits, performing relatively poorly on the Wechsler and Stanford Tests. Prediction from the Metropolitan Readiness Tests might be improved if this test were augmented by further auditory assessment.

The breadth of the abilities assessed by the Wechsler test is impressive and may indicate primarily that this is an excellent measure of general ability. Because the Wechsler includes so wide a variety of abilities, it may not be the best predictor of school achievement at this level, as more limited abilities may serve as the basis for early school learning.

The prediction of the Stanford scores was at a disappointingly low level. Both auditory and visual abilities appeared to be related to all subtests.

In summary, the range of abilities assessed by the Metropolitan Readiness, Wechsler Intelligence and Stanford Achievement tests at the grade one level appeared to be different in this study. The Wechsler appeared to tap a very wide range of abilities, the Metropolitan

appeared to tap visual more than auditory abilities and the Stanford appeared to tap both auditory and visual abilities to some extent.

Some of the tests used in this study are discussed further in Appendix B.

Discussion of Future Research

Further research is needed to determine whether the concept of ability hierarchies is useful. Research with groups of subjects similar to those used in this study might indicate whether an hierarchical arrangement of abilities appears with other samples.

A major premise made in this study was that the identity and relative influence of abilities in a hierarchy change according to the nature of the criterion variable. It may be that similar differences in the hierarchical abilities associated with reading, arithmetic and intellectual development change with the level of development, as well. As an example, arithmetic at the grade three level may require a different hierarchical structure to that needed for arithmetic at the early grade one level. This could be investigated by using a research design similar to the design used in this study, but selecting slightly older subjects.

Perhaps the most effective method of assessing the validity of the hierarchical ability approach to early child development outlined here would be to use a controlled classroom situation. Two groups of high-risk preschool children with similar development of basal and integrated abilities could be located. One group could be assigned to an experimental classroom in which programs for the development of

deficient basal and integrated abilities would be carried out. The second group could be placed in a control classroom in which a regular preschool program is followed. If the experimental group were to show significantly better readiness abilities, early academic progress and intellectual development in grade one than the control group, this could be considered some validation of the effectiveness of programming to improve ability hierarchies.

The approach used in this study could be expanded to investigate the abilities needed for maximum learning by various teaching methods. It would be possible to find grade one classes where a word recognition approach to reading is stressed, as in the Ginn (Ginn, no date) reading series, and other classes where a phonetic approach to reading is stressed, as in the Lippincott (McCracken, 1969) reading series. Basal and integrated abilities most related to success with the two reading methods could be identified and compared. This sort of information might provide useful insights into the selection of teaching methods most likely to be successful with children considered to be in high risk of school failure.

A more specific area of research would involve the use of a battery of diagnostic reading tests and the ability tests used in this study. It would be useful to have information on the areas of the reading process which are most related to basal and integrated abilities, to allow for increased understanding of the relationships between the reading process and underlying abilities.

The same type of analysis might be applied to various methods of teaching arithmetic. A superficial examination of the materials used would seem to indicate that the Seeing through Arithmetic (Hartung, 1967) approach may involve strong auditory memory and vocabulary components, while the Cuisiniere (Gattegno, 1960) method may rely more strongly on spatial abilities. The use of diagnostic arithmetic tests with a learning ability battery might provide useful information on ability deficits which show significant relationships with early arithmetic achievement.

Vernon's (1960) discussion of Intelligence C, the relationship between test scores and the attribute which supposedly is sampled, is relevant to the investigation of possible hierarchical structures of learning abilities. The attribute sampled, for example, auditory discrimination, receptive vocabulary or visual memory, is of prime importance. The test score obtained is important only as it is judged to be an effective indication of the attribute. The validity of the hierarchical ability structure could be investigated using alternate tests which appear to measure the abilities assessed in this study.

In summary, if relatively reliable and comprehensive ability structures can be identified by future research, these structures could provide a method of examining academic programs and teaching methodologies as well as determining the content of remedial/developmental programs for groups of children with learning difficulties.

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APPENDIX A

Hypothetical Case Study of Preschool Child

Name: Jake   Chronological Age: 5-1   Placement: ___ Preschool Class

Information From Screening Procedures

1. Observations

   a) Gross motor development - catching, running, jumping are adequate.

   b) Fine motor development - cannot button clothing, dry hands, use scissors or crayons.

   c) Social-emotional development - good. Plays well with children and responds well in situations with adults.

   d) Speech and language development - slightly inadequate for age. Sound substitutions (baby talk) prevalent. Seems to say little when he speaks.

2. Queries - as fine motor skills are poorly developed, how much of this poor development is due to lack of practice? Is spatial orientation a problem?

   - in view of inadequate language development, does Jake have adequate hearing? Is he bilingual? What is his level of vocabulary and how well does he comprehend oral instructions?

   - what is the family background and how much can Jake's parents be expected to do at home with him?

3. Medical Information

Jake was assessed by the school speech clinician. No indications of hearing difficulties were found. Speech mechanisms were examined and found to be normal.

4. Family Background

Jake's parents came readily for an interview with school personnel. Jake has no known history of medical difficulties or developmental problems. The family is unilingual.

Jake is the youngest child in the family. Four older children range in age from ten to nineteen years. The family appears to be very close, sharing in a variety of outdoor activities including camping, boating and participant and observer sports. Jake's parents feel that his older siblings may be overprotecting Jake and "doing too much for him." Training in self-help skills such as dressing and drying of hands, as well as the possibility that Jake's family may be inadvertently prolonging "baby talk" was discussed. Contact with the family will be maintained.

<u>Information From Formal Assessment</u>

1. Integrated abilities - receptive vocabulary - Peabody Picture Vocabulary Test - Jake's age score is below three years.
   - meaningful auditory memory - Memory for Related Syllables from the Detroit Tests of Learning Aptitudes - Jake's age score is again below three years.

1. Integrated abilities (continued) - spatial orientation - Frostig Developmental Test of Visual Perception - subtests III, IV and V. Composite age score approximately 4 years. Difficulties were noted in recognizing and recalling simple shapes.

2. Basal abilities
   - auditory discrimination - Goldman-Fristoe-Woodcock Test of Auditory Discrimination - very weak development. Most medial and final consonants are confused.
   - auditory closure - Illinois Test of Psycholinguistic Abilities - weak development. A quiet area will be used for developmental language exercises.
   - visual sequential memory - Visual Attention Span for Objects subtest of the Detroit Tests of Learning Aptitudes - adequate performance
   - auditory sequential memory - Illinois Test of Psycholinguistic Abilities - adequate performance.

Summary

There appear to be no underlying sequencing problems in basal abilities. Jake appears to need further development in the areas of form recognition, general spatial orientation, copying, auditory

discrimination, vocabulary and meaningful auditory memory. The production of adequate speech sounds will be encouraged. The parents will be kept informed of Jake's program and will be encouraged to participate in this program both in the classroom and at home.

Programming

Jake is considered as having a moderate problem in speech/language development and a minor problem in the development of visual discrimination and fine motor activity. His preschool program will initially be divided with one-third of his time being spent in small group speech/language activities, one-sixth of his time in small group visual-motor and visual perceptual training activities and one-half of his time in general preschool activities. Small group activities will present a concentration of activities in Jake's weaker areas given in more depth than are the activities which are included in the regular preschool program.

1. Auditory discrimination training - major source of activities Oakland and Williams (1971).

   Gross auditory discriminations - comparison and identification of substances in closed containers, pebbles, sand, water, etc.
   - matching sounds of noisemakers, as whistles, drums, rattles, from gross differences to pitch differences with same noise.

1. Gross auditory discriminations - sight and sound identification (continued)

proceeding to sound identification only of common objects - from locating sounds in environment to their identification on a record or tape recording.

- sound vocabulary - high, low, loud, soft.
- pitch and volumn reproduction - simple music using piano and records. Singing and speaking loudly, softly, etc.
- rhythmic development - clapping, skipping, walking, rocking to various rhythms.

Speech discriminations - simple stories, rhymes and songs with repetitious sounds repeated by children. Seating arranged to encourage children to watch instructor's face.

- use of simple pictures to elicit speech sounds.
- adaptations of sound games such as "I spy".
- rhyming activities, simple picture card games matching initial, rhyming and ending sounds, clapping and other motoric responses to same and different words.

1. Speech discriminations (continued) - preschool speech sound games, as those outlined in Van Riper (1951).

2. Vocabulary development - expressive and receptive.
   - initially, new words tied to concrete experiences - objects and activities in classroom. Review of new words at regular intervals. Short "field trips" to school custodian's supply room, furnace room, staff room, kitchen area, school yard, etc. to allow use of new words in context, pictures of "trips" for child to discuss in small group and at home.
   - use of prepositions, pronouns, verb tenses gradually introduced.
   - use of Peabody Language Development Kit P level (Dunn, Smith & Horton, no date), or similar multipurpose language materials.
   - discussion of pictures in books being read to children.
   - Illinois Test of Psycholinguistic Ability verbal expression type of exercise, describing common objects in terms of their appearance, colour, use, etc.

3. Visual discrimination - comparison of concrete objects, from toys to wooden shapes - same, different, larger, smaller.
   - recognizing similarities and differences in simple line drawings.
   - using formboards ranging from simple to complex.
   - filling in simple missing parts in pictures and puzzles, using "Find the Hidden Figure" puzzles.
   - shape recognition from matching three dimensional shapes to finding similar shapes in the room, in pictures, among groups of shapes.
   - learning vocabulary to allow the discussion of shapes, as circle, square, triangle, longer, shorter, straight, round, angles (or corners), one, two, three, four, etc.

4. Visual-motor skills - after simple shape discrimination has been adequately developed, tracing around large circles, ellipses, rectangles, triangles.
   - shape drawing without tracing and shape copying with multiple stimuli.

4. Visual-motor skills (continued) - tracing, colouring and cutting simple line drawings.
   - general cutting, colouring and drawing activities with an emphasis on large, simplified figures initially, with gradual progression to more complex figures requiring increased ability in discrimination and motor control.

Many of these activities are included in the regular preschool program. Jake will be given additional experience as needed in a small group of children needing this type of development.

Reassessment

As Jake's development in deficient areas improves, time allotments may be changed. It is anticipated that Jake's difficulty in the perceptual-motor area will be overcome relatively readily. Depending upon Jake's progress in achieving normal language abilities, particularly in the integrated abilities of receptive vocabulary and meaningful auditory memory, the time allotted for him to work in the language area may be increased later in the year. Should the integrated abilities be assessed as up to or very close to Jake's chronological age, his full time may be allotted to the regular preschool program.

APPENDIX B

Discussion of Some Tests Used in the Study

Criteria Tests

1. Metropolitan Readiness Tests

a) Word Meaning Subtest

Test results for this subtest showed the strongest relationships with receptive vocabulary and meaningful auditory memory, with smaller but significant relationships with the recognition of embedded figures and parts of the Frostig test. This test assessed the ability to relate a spoken word with a picture. This study appeared to indicate that poor performance in Word Meaning might tend to be related most strongly to vocabulary and auditory memory deficiencies and less strongly to poor visual perceptual abilities.

b) Listening Subtest

Receptive vocabulary and spatial orientation were most strongly related to subtest scores, while meaningful auditory memory showed a significant but weaker relationship. In this subtest a spoken sentence is related to a picture. The sentences used in this subtest apparently were not of sufficient length for meaningful auditory memory to become a major factor. It appeared that a poor score, with this sample, might be related to inadequate development of receptive language and/or poor spatial orientation.

c) Matching Subtest

This subtest showed barely significant relationships with auditory abilities. Relationships with visual abilities, particularly with the Frostig spatial orientation subtests were stronger. Spatial orientation appeared to be an important ability in this subtest.

d) Alphabet Subtest

This subtest, which assesses the ability to discriminate and identify letters, appeared to be most related to spatial orientation with weaker but significant relationships with receptive vocabulary and nonmeaningful auditory memory.

e) Numbers Subtest

This subtest which samples a variety of abilities involving early arithmetic processes showed significant relationships with all auditory and most visual abilities. Meaningful auditory memory, receptive vocabulary and spatial orientation showed the strongest relationships. The numbers subtest appeared to be the most complex subtest of the Metropolitan in that it showed the largest number of significant relationships with integrated and basal abilities.

f) Copying Subtest

The copying subtest showed significant relationships with all Frostig subtests as well as with the integrated abilities of meaningful auditory memory and receptive vocabulary.

In examining Metropolitan total scores, spatial orientation showed the strongest relationship with total scores. All subtests

showed significant relationships with auditory and visual abilities. This may indicate that while a child's problem may appear to lie in the area of auditory abilities when judged from readiness scores, it may be necessary to assess for difficulties in visual abilities, as well.

In general, the Metropolitan Readiness Tests may have a stronger component of visual perceptual abilities than is required for prediction of future school success.

2. Stanford Achievement Tests

In general, relationships between criteria and predictor variables were stronger for the readiness tests than for the achievement tests, which may indicate that the achievement tests are related to a range of variables, many of which were not included as predictors in this study. In most cases, the relationships between auditory abilities and achievement in reading, arithmetic and spelling were stronger than the relationships between visual abilities and achievement. This is in contrast to the relationships found for the readiness tests. It may be possible for a child to receive good scores on the visually loaded Metropolitan and poor scores on the Stanford achievement because of this difference in related underlying abilities.

3. Wechsler Intelligence Scale for Children

The best predictor of the Wechsler total score was the Frostig total score, followed by meaningful auditory memory. Receptive vocabulary showed only the fifth strongest relationship with Wechsler total score.

Most subtests showed significant relationships with both auditory and visual abilities. The number of auditory and visual abilities found to be related to each subtest is given in Table 1B.

If the number of significant relationships found between Wechsler subtest scores and the auditory and visual measures used in this study can be assumed to assess the complexity of the abilities tapped by the subtests, Arithmetic, Digit Span and Block Design were the most complex subtests for this sample. It might follow that, because these three subtests tap the largest number of abilities assessed, they may be useful as indicators of general competence at this age. High performance in these three subtests may represent better general underlying ability development than would be indicated by high performance in less complex subtests such as Picture Completion, Coding and Picture Arrangement.

While most of the Wechsler verbal subtests showed significant relationships with approximately equal numbers of auditory and visual abilities, most of the Performance subtests showed few relationships with auditory abilities. This relative specificity of the Performance subtests again was evident in comparing the number of auditory and visual abilities found to be related to the total Verbal and Performance scores. It might be argued that, with this sample, the Verbal subtests tended to show considerably more relationships with visual abilities than would be expected and, because of this, the Verbal score may indicate more of a general ability measure, rather than a more limited measure of auditory abilities. Visual abilities may have been overly represented in the intellectual assessment of the subjects in this study.

TABLE 1B

Number of Statistically Significant Relationships

Found Between Wechsler Subtest Scores and

Auditory and Visual Measures

Wechsler Subtest Scores	Auditory Measures	Visual Measures	Total Auditory & Visual Measures
Information	5	5	10
Comprehension	4	5	9
Arithmetic	6	7	13
Similarities	4	4	8
Vocabulary	7	2	9
Digit Span	6	7	13
Picture Completion	0	3	3
Picture Arrangement	1	4	5
Block Design	3	9	12
Object Assembly	1	7	8
Coding	0	4	4
Verbal Score	7	8	15
Performance Score	1	8	9
Total Score	6	9	15

Predictor Tests

1. Memory for Related Syllables - Detroit Tests of Learning Aptitudes

Despite the limited norming population used by the authors of the Detroit, this subtest of sentence repetition was the single best predictor in the battery used for Wechsler verbal and total scores and for Stanford arithmetic. It was strongly related to nonmeaningful auditory sequential memory, receptive vocabulary, auditory closure and auditory discrimination. Sentence memory was tentatively identified as representing an integrated auditory ability which appeared to depend in part on the development of basal abilities.

Because of the value of sentence repetition both as a predictor variable and as a screen for underlying basal abilities, it appeared to be an extremely useful assessment technique to be included in any battery of learning ability tests.

2. Frostig Developmental Test of Visual Perception

Despite previous indications that the Frostig might be a single factor test (Buros, 1972), the subtests tended to divide into three areas in this study. Subtests 3-Form Constancy, 4-Position in Space and 5-Spatial Relations tended to show similar relationships with other variables and, together, were taken as components of the ability described in this study as spatial orientation. In many areas, subtest 2-Figure-Ground Discrimination, showed similar relationships to the spatial orientation subtests. However, subtest 2 was slightly different to spatial orientation in its relationships with Stanford arithmetic

scores (Figure 7) and considerably different in its relationship with the auditory sequencing abilities of sentence and digit repetition (Table 14).

Subtest 1 of the Frostig, Eye-Motor Coordination, showed only limited relationships with other variables and was the least efficient predictor among the Frostig subtests.

Various of the Frostig subtests, particularly those included as spatial orientation, were useful as predictor variables in this study.

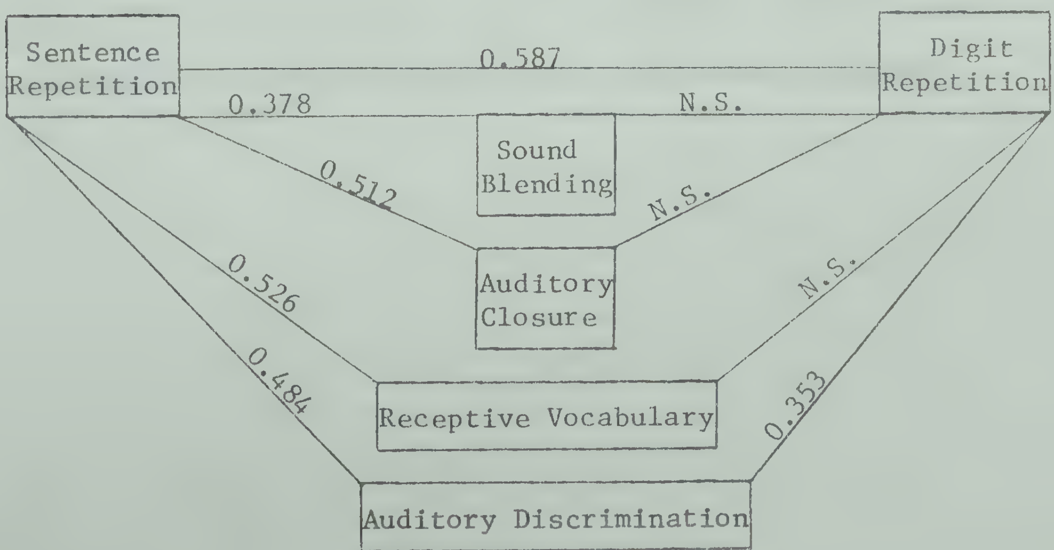
3. Illinois Test of Psycholinguistic Abilities - Auditory and Visual Sequential Memories, Auditory and Visual Closure and Sound Blending

Auditory sequential memory (digit repetition) showed the strongest relationships with other variables. It was particularly useful to compare with sentence repetition. Figure 1B shows some of the differences which appeared between sentence repetition and digit repetition.

Figure 1B

Relationships Among Sentence Repetition,

Digit Repetition and Other Measures



Sentence and digit repetition showed a strong relationship with each other, while their relationships with other auditory abilities were considerably different. In learning ability assessments it may be incorrect to assume that sentence repetition and digit repetition are essentially the same and that success in one precludes difficulty in the other. Digit repetition may reflect an underlying spatial-sequencing ability in a relatively limited way, while sentence repetition showed additional strong relationships with receptive vocabulary, auditory closure and other abilities.

In general, the remaining Illinois subtests showed relatively limited relationships with other measures, although prediction was slightly increased by their use in some instances.

4. Peabody Picture Vocabulary Test

Receptive vocabulary like sentence repetition and spatial orientation tended to show fairly strong relationships with most criteria variables. There were significant relationships with several visual measures. This may be related to the need for the accurate interpretation of pictures in this test. It may be misleading to describe the Peabody as a test of receptive vocabulary when visual perceptual abilities may influence the scores obtained.